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PRELIMINARY INSTRUCTION MANUAL FOR AN/CP-191(XB-1)/SPG COMPUTER-TRACKER, RADAR UNIT FOR USE WITH GUN FIRE CONTROL SYSTEM MARK 37

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ABSTRACT

The AN/CP-191(XB-1)/SPG Computer-Tracker, Radar Unit is an experimental unit designed for fleet evaluation of the reduction in gun-order dispersion of the Gun Fire Control System Mark 37, under the adverse tracking conditions of low-evaluation-angle aircraft attack and of large surface ship attack. This reduced dispersion is due to improved operation of the Computer Mark 1A as provided by Ordnance Alterations 2626 and 3091, and to improved automatic tracking of the Radar Mark 25 Mod 2 as provided by this unit under these conditions. The improved tracking is the result of providing tracking performance commensurate with possible aggressive target maneuvers. This is achieved by reducing the bandwidths of the elevation and train automatic servos and by the introduction of servo error signal limiting.

PROBLEM STATUS

This is an interim report; work is continuing on the problem.

AUTHORIZATION

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The modifications to the radar automatic-tracking equalizer characteristics normally provided by the unit are:

(1) unsymmetrical limiting of the Elevation D-C Error Signal,

(2) reduction of the Elevation Servo bandwidth by a factor of 10,

(3) symmetrical limiting of the Train D-C Error Signal, and

(4) reduction of the Train Servo bandwidth by a factor of 10.

The two active modes of operation of the unit which may be selected are "Low Angle Aircraft Target" and "Large Surface Target." The modes are indicated at the remote control-box and on the front panel of the unit by lights. Bandwidth filter zero and limiting-level voltages are metered and adjusted from the front panel of the unit.

Elevation and range synchro control transformers are electrically zeroed by adjustment of the position of mechanically locked rotors, whose shafts are accessible from the front panel, and whose shaft locks are accessible from the sides of the chassis. Potentiometers, which set the operation level of the relays that define the limits of the adverse tracking region for the equipment, are located on the top of the chassis behind their respective synchro control transformers. Four toggle switches to locally establish modes of operation are on the back of the front panel. The time delay which allows the charge on the reduced bandwidth filter condensers to stabilize may be adjusted from the top of the unit.

THEORY OF OPERATION

The AN/CP-191(XB-1)/SPG Computer-Tracker, Radar Unit performs two related functions. The first function is that of defining the coordinates of the adverse tracking region for low-elevation-angle aircraft and large surface ship targets in terms of radar range, director elevation, and the time that the radar has been in automatic tracking with normal servo equalizer characteristics. The second function is that of restricting the radar servo equalizer bandwidths and the d-c error signals such that only error-signal components of apparent target motion which are within the maneuvering ability of the actual target are followed by the antenna.

The apparent target motion differs from the actual target motion because of the inability of the radar to resolve adequately two "centers of reflection" within the tracking beam of its antenna. These "centers of reflection" (for the Radar Mk 25, Mod 2) may be the energy reflected from an aircraft flying below a director elevation angle of 2 degrees and its image in the water, two or more high-level aircraft flying on the same course and at the same speed less than 2 degrees apart in elevation or train, or several portions of the reflecting surface of a large vessel. The path difference between the radar and each "center of reflection" results in different rf phase angles for the two components of the received signal. The unresolved resultant energy from these "centers of reflection" is the apparent target which the radar tracks within the restriction of its servo bandwidth. When the path distance between the antenna and the centers of reflection is an odd multiple of one-half wavelength, a phase difference of 180 degrees exists, and for equal amplitudes cancellation results. For even multiples, reinforcement results, and for intermediate path differences, varying degrees of cancellation and phase shift result. The apparent target motion has a large dispersion about the optical line of sight to the actual target because of the continuously varying phases and amplitudes of the rf energy from these "centers of reflection," which arises principally from the changing geometry of their positions and the varying coefficient of reflection of the underlying water surface.

Analysis of the radar tracking deviations in the adverse tracking region indicates that the radar angle-servo system follows error voltages containing large-amplitude high-frequency components which represent accelerations exceeding any possible actual target maneuver. Therefore, by limiting the amplitude of the d-c servo error signal and further restricting the bandwidth of the servo equalizers in a manner which inhibits only their response to acceleration components of the error voltage, the automatic radar tracking more closely follows the motion of the actual target. In the low-elevation-angle aircraft-target problem, analysis of the radar tracking deviations, when only the servo bandwidth is reduced, indicates that the apparent target lies below the actual target and near the water surface during a large percentage of an attack run. The inability of the plane to dive in this situation permits the use of unsymmetrical limiting of the error voltage. In this manner it is possible to compensate for the position of the apparent target by limiting error signals tending to drive the antenna downward more severely than error signals tending to drive the antenna upward. These principles of operation are designed into the equipment as explained in the following paragraphs. Frequent references will be made to the equipment illustrated in Appendixes C and D.

In the director elevation angle monitor circuit, B1 is a synchro control transformer with a mechanically locked rotor whose stator windings are excited from the 2-speed director elevation synchro generator. The wattless current drawn by the control transformer is compensated by the synchro-exciter C2. T3 supplies an increment of voltage in phase with the synchro rotor excitation bus to provide an "anti-ambiguity" voltage. C3 and C7 optimize the phase of the "anti-ambiguity" voltage. T1 couples these voltages with a 3-to-1 voltage step-up to the diode-connected portion of V3 which develops a half-wave rectified voltage across the load R8-C4. The voltage developed across C4 is coupled through R9 to the grid of the amplifier section of V3. Relay K1, plate load of V3, will be energized when the voltage on the grid of V3 rises to a value equivalent to a director elevation angle of 2 degrees, determined by the cathode bias on V3 obtained by the voltage divider R12 and R11 plus R10. C5 provides a cathode signal bypass. Above 2 degrees, the normally closed contact of relay K1 is opened preventing application of reduced bandwidth and limiting. The director elevation-angle monitor with its anti-ambiguity circuit operates satisfactorily for director elevation angles between approximately -20 and +90 degrees elevation. Above +90 degrees director elevation angle, the present electronic monitor circuit permits limiting and smoothing circuitry to be reintroduced. In production equipment, this monitor would be replaced by a microswitch and cam located on a low-speed director elevation shaft or would use the 115 volts, 60-cycle, 1-phase voltage available from the Mk 1A computer (with Low-Angle OrdAlts) below 20 degrees. However, the use of the computer voltage requires energizing the computer which may not be desirable in all situations.

At ranges less than 3,000 yds, excessive accelerations are generated by the target, which require that the normal bandwidths be restored. This is performed by the radar-range monitor circuit consisting of C6, B2, T2, V4, R13, C8, R14, K9, R15, R16, R17, and C9 which performs the same type of operation as the director-elevation monitor circuit, with the exception that no attempt has been made to extend its range of operation beyond 34,000 yds because of the advance range limit of the Computer Mk 1A and range of 5"/38 cal guns. Relay K9 activates normally open contacts to permit angle-error-signal limiting and servo bandwidth reduction within the ranges of 3,000 and 34,000 yds.

If the target has been established within the low-angle region by the range and elevation monitor circuits, and if the elevation automatic relay K4 is energized from the radar Mk 25 "automatic elevation enabling" relay excitation, and if the train automatic relay K6 is energized from the radar Mk 25 "automatic train enabling" relay excitation, then the 2-second time delay relay K5 provides excitation to the tracking characteristics modification functions of the unit.

Now, when the remote control switch is actuated to the "Low Angle Aircraft Target" position, the elevation-signal limiting relay K2 is energized. Then V1 limits the radar elevation-error signal to +4 volts for signals driving the antenna up, and to -2 volts for signals driving the antenna down, as determined by the adjustment of R2 and R3. Indicator I_1 is illuminated at the unit at this time. At the same time the elevation reduced-bandwidth relay K3 is energized, placing R5 in parallel with the 62.5K resistor of the network Z(17A1)1, and placing C1 (225 μfd) in parallel with C(17A1)2 (16 μfd). This reduction in the bandwidth of the elevation equalizer maintains the servo response to position and velocity components of the error signal, but reduces the response of the radar-director system to acceleration errors. V2 is a cathode follower which maintains the average charge on C1 at very nearly the same value as that on the radar elevation equalizer condenser C(17A1)2. The potentiometer R6, "Elevation Filter Zero," may be adjusted so that the charging of C1 by the error voltage will be about a mean value of zero volts equivalent to zero elevation error. V7 and V8 limit the voltage to -125 volts across C1 which under unusual conditions could be -300 volts.

When the remote control switch is actuated to the "Large Surface Target" position, the elevation-servo bandwidth is reduced and in addition K7 and V5 reduce the train-servo bandwidth and K8 and V6 limit the train-error signal to ±3 volts in the same manner as in the elevation coordinate.

INSTALLATION AND ALIGNMENT

The AN/CP-191(XB-1)/SPG Computer-Tracker, Radar Unit should be located near the main frame components of the Radar Mark 25 Mod 2 with the remote control-box located at the Computer Mark 1A on its Star Shell Computer portion, beneath the Target Course Indicator. The unit is provided with a shock-mounted frame which can be tack-welded to either the deck or bulkhead, depending on whether a horizontal or vertical mounting is preferred. As supplied, the equipment is arranged for horizontal mounting. To mount vertically, invert the case in the shock-mount frame. Tapped holes in the case are provided. This places the top of the unit against the bulkhead.

Cabling of the unit to the Radar Mk 25 Mod 2 is made to external cable terminal boards, with the exception of the connections to the train and elevation equalizers which are not normally brought to these boards. One connection is brought to the elevation-servo amplifier at terminal 17(A1)3 and another to the train-servo amplifier at terminal 17(A2)3. Also, a connection is brought to the elevation-equalizer network at terminal Z(17A1)1-3 and similarly in train at terminal Z(17A2)1-3. In order to keep noise and cross-talk isolated from the angle-error servos, care should be taken to prevent grounding the elevation- and train-signal grounds to each other or to chassis ground.

When the cabling has been completed and continuity of wiring checked, a visual inspection of the unit should be made prior to turning power on the Radar Mark 25 Mod 2. Particular attention should be given to the over-load protection voltage regulator tubes V7, 8, 9, and 10. With the radar power off, they may be individually checked across the 115-volt line to determine that they fire. These tubes prevent the supply voltage of -300 volts from being applied across the 225 μfd banks of 10 μfd condensers which are rated at 100 WVDC and tested at 200 vdc. This condition could occur should the filaments of the cathode follower tubes V2 and V5 fail. The use of these condensers was dictated by space requirements and their normal maximum operating voltage of ±20 volts.

With the Radar Mark 25 Mod 2 operating in "Manual" tracking of random noise, the train and elevation "filter zero" potentiometers (R18 and R6, respectively) should be

carefully adjusted to place zero volts on their filter condensers as measured by the meter on the front panel of the unit. Again, with the aid of the front panel meter, adjust R23 ("Right Limit") to limit the train d-c error signal to -3 volts, R22 ("Left Limit") to limit the train d-c error signal to +3 volts, R2 ("Down Limit") to -2 volts, and finally R3 ("Up Limit") to +4 volts.

With the Gun Director Mark 37 maintained manually at a director elevation of 0 degrees electrically zero (measuring voltage at the primary of transformer T1) the Elevation Monitor Synchro Control Transformer "B1" of the Unit. Next observe that the phasing of the "anti-ambiguity" voltage provided by transformer T3 is correct by noting that when the Gun Director is elevated to 90 degrees there is a residual voltage at the primary of transformer T1 of approximately 6.3 volts a-c. With the Gun Director set at an elevation angle of 2 degrees, remove the dust cover of relay K1 and set the relay activation level of the Elevation Monitor amplifier by adjusting R10 to energize relay K1 by observation of its armature. This voltage on pin 4 of V3 should be approximately 10 volts. Starting at a high elevation angle, observe that relay K1 is energized at 2 degrees director elevation when the antenna elevation angle is being reduced. If the elevation angle is being increased from below 2 degrees, the hysteresis of the relay coil does not allow the relay to become de-energized until approximately 3 degrees when it is again elevated. Check that relay K1 is <u>not</u> energized between director elevation angles of 3 and 90 degrees.

Although normal procedure requires that radar-range synchros be electrically zeroed at mechanical 10,000 yds, the range-monitor circuit requires that the synchro-control transformer B2 be electrically zeroed and locked at mechanical zero. Then, with the radar range unit set at 3,000 yds, remove the dust cover of relay K9 to observe the motion of its armature. The gain of the range-monitor amplifier V4 should be adjusted to energize relay K9 at 3,000 yds radar range with approximately 10.0 volts on pin 4 of V4. Note that when range is increased, relay K9 will be de-energized at approximately 4,000 yds because of the hysteresis of the coil. Also observe that the relay K9 will be de-energized in the region of radar ranges of 32,000 to 34,000 yds because of the inherent limitations of this type of circuit. These ranges are beyond the advance range capabilities of the Computer Mk 1A and the 5" 38 cal guns.

OPERATION

Remote manual selection of the mode of operation of the AN/CP-191(XB-1)/SPG Computer-Tracker, Radar Unit is performed at the Computer Mk 1A, or for the alternative location of the control box, between the pointer and trainer positions of the Gun Director Mark 37. For this selection, a small control box is provided which contains a three-position toggle switch and its associated indicator lights. The switch positions are designated: on the left with its red indicator light, "Low Angle Aircraft Target;" in the center, "Normal;" and on the right with its green indicator light, "Large Surface Target." Note that no indicator light is provided for "Normal" radar operation.

Whenever an aggressive aircraft target is tracked by the Radar Mark 25 Mod 2 in the region below 2 degrees director elevation, the computer elevation operator should (1) observe that the "Rate of Climb" (dH) dial is driven automatically to zero on the Computer Mark 1A (or if OrdAlts 2626 and 3091 have not been completed on the Computer, it will be necessary to place the "Rate of Climb" knob in "Manual," set it to zero, and leave it at zero in this region) and (2) throw the remote selector switch of the AN/CP-191(XB-1)/SPG unit to the "Low-Angle Aircraft Target" position. For this type of target the radar-elevation-servo equalizer bandwidth is reduced to 1/10th its normal value and the radar elevation d-c error signal is unsymmetrically limited to +4 volts for signals driving the antenna above

the target and to -2 volts for signals driving the antenna below the target. The red "Low-Angle Aircraft Target" indicator will be illuminated when the switch has been thrown to this position and the radar has been automatically tracking an aircraft target below 2 degrees director elevation and beyond 3,000 yds for at least 2 seconds.

Whenever a large surface target is tracked by the Radar Mark 25 Mod 2, the computer train operator should (1) observe that the "Rate of Climb" (dH) dial is driven automatically to zero on the Computer Mark 1A (or again if OrdAlts 2626 and 3091 have not been completed on the Computer, it will be necessary to place the "Rate of Climb" knob in "Manual," set the dial to zero, and leave it at zero in this region) and (2) throw the remote selector switch of the AN/CP-191(XB-1)/SPG unit to the "Large Surface Target" position. For this type of target the radar elevation- and train-servo equalizer bandwidths are reduced to 1/10th of their normal values, and the radar-train d-c error signal is symmetrically limited to ±3 volts which is equivalent to limiting the signal to angular errors of approximately ±3 milliradians. The green "Large Surface Target" indicator will be illuminated when the switch has been thrown to this position and the radar has been automatically tracking the ship target beyond 3,000 yds (and also below 2 degrees director elevation) for at least 2 seconds.

OPERATOR'S MAINTENANCE

In the routine inspection of the radar equipment which the operator makes in order to report malfunctions to the radar technician, the operator should note the functions of the externally observable switch, lights, and meter. Operator's controls are shown in Table 1.

The radar pointer and trainer can ascertain that the AN/CP-191(XB-1)/SPG Unit is probably performing its functions properly by observing the resultant tracking optically. An isolated target below 2 degrees is preferred, but an aircraft target above 2 degrees may be observed by temporarily by-passing the Elevation and Range Monitors with the "E + R Control By-Pass" switch just inside the front panel. Because of the greater elevation and train rates possible for targets above 2 degrees at close ranges, targets must be observed at greater ranges where the angular accelerations are lower. THE "E + R CONTROL BY-PASS" MUST BE RETURNED TO NORMAL WHEN THE CHECK HAS BEEN COMPLETED. With the remote switch in the "Low-Angle Aircraft Target" position, the elevation "jitter" will be extended from a nominal 3-second period to a nominal 30-second period, while train wander will remain the same. (The large reduction in the amplitude of the elevation "jitter" will make the amplitude of the train jitter appear greater than normal by comparison.) Similarly in the "Large Surface Target" position, both the train and elevation periods will be extended from a nominal 3 seconds to a nominal 30 seconds. IF THE "E + R BY-PASS" SWITCH HAS BEEN ACTUATED IT SHOULD BE RETURNED TO NORMAL AT THIS TIME.

CORRECTIVE MAINTENANCE

When a visual inspection reveals that V7 and V8, or V9 and V10, are conducting, with V2 and V5 in their sockets, V2 or V5 must have an open filament. This unusual condition would place -300 volts across C1 or C10 which are rated at 100 volts d-c and tested at 200 volts d-c, except for the protection of the series voltage regulator tubes V7 and V8, and V9 and V10, which conduct at 175 volts.

TABLE 1
Operator's Controls

Control Position	Type	Designation	Function
Remote Control-Box			
"Low-Angle Aircraft Target"	DPTT Toggle switch, (3-position)	S1 (position 1)	Limits elevation-error signal to +4 v, -2 v; reduces servo equalizer bandwidth to 1/10 normal value.
"Normal"	"	S1 (position 2)	Removes AN/CP-191(XB-1)/SPG from radar for evaluation of normal operation.
"Large Surface Target"	'	S1 (position 3)	Limits train error signal to ±3 v; reduces train and elevation-servo equalizer bandwidths to 1/10 normal value.
AN/CP-191(XB-1)/SPG Computer-Tracker, Radar Unit			
Meter Switch	(7-position)	S1	
1			Elevation "Down" limit -2 v
2			Elevation "Up" limit +4 v
3			Elevation "Filter Zero"* 0 v
Off			0 v
4			Train "Left" limit +3 v
5			Train "Right" limit -3 v
6			Train "Filter Zero"* 0 v

* This reading will only be correct when the radar is in the "Manual Tracking" condition

It should be noted, when checking the operation of the switches on the backside of the front panel, that the simplified functions performed by the remote control-box effectively by-pass these switches. That is, when the remote switch is thrown to the "Low-Angle Aircraft Target" position, the "Elevation Reduced Bandwidth" and the "Elevation Signal Limiting" indicators will be illuminated locally. The same result can be obtained locally by actuating either the "Elevation Narrow Band" or "Elevation Limiting" switches. Similarly, when the remote switch is thrown to the "Large Surface Target" position, the "Train Reduced Bandwidth and Limiting" and the "Elevation Reduced Bandwidth" indicators will be illuminated locally. The same result can be obtained locally by actuating only the "Train Narrow Band and Limiting" switch. In order to investigate individually any of these functions, it is only necessary to remove the plug-in relays which should not be energized. For example, it will then be possible to isolate the effect of limiting on the train- or elevation-servo error signal and by connecting the test scope to TP(17A)1 in the Radar Tracker (Automatic) Unit of the Radar Mark 25 Mod 2, the effect may be observed.

ACKNOWLEDGMENTS

The development reported here represents the most recent product of a relatively large group of people that have been continuously engaged in this and closely related fields from a date preceding World War II. Members of the Equipment Research Branch, Peter Waterman, Head, and the Operational Research Branch, James J. Fleming, Head, are those who have contributed most heavily. Mr. Charles F. White and the author, both of Equipment Research Branch, Radio Division III, were those most directly concerned with the application of the techniques discussed to actual fleet-installed equipment.

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* * *

APPENDIX A
Parts List

Part No.	Discription	Replacement Check List
R1	75K, 2w, wire wound	
R2	2K, 1w, wire wound, 10 turns; 0.1% tol; HELIPOT	
R3	2K, 1w, wire wound, 10 turns; 0.1% tol; HELIPOT	
R4	75K, 2w, wire wound	
R5	20K, 1w, wire wound	
R6	5K, 1w, wire wound, 10 turns; 0.1% tol; HELIPOT	
R7	75K, 2w, wire wound	
R8	510K, 1w	
R9	100K, 1w	
R10	2K, 1w, wire wound, 10 turns; 0.1% tol; HELIPOT	
R11	1K, 1w, wire wound	
R12	100K, 1w	
R13	510K, 1w	
R14	100K, 1w	
R15	2K, 1w, wire wound, 10 turns; 0.1% tol; HELIPOT	
R16	1K, 1w, wire wound,	
R17	100K, 1w	
R18	5K, 1w, wire wound, 10 turns; 0.1% tol; HELIPOT	
R19	75K, 2w, wire wound	
R20	20K, 1w, wire wound	
R21	75K, 2w, wire wound	
R22	2K, 1w, wire wound, 10 turns; 0.1% tol; HELIPOT	
R23	2K, 1w, wire wound, 10 turns; 0.1% tol; HELIPOT	
R24	75K, 2w, wire wound	
R25	200K, 1/2 w, wire wound, 1% tol; (MTD. ON MI)	
C1 A thru X	225 μfd, 100 vdc, 24 units , 10 mfd each (2 units in series)	
C2	.6-.6-.6 μfd, 90 vdc, BuOrd Synchro Capacitor with brackets	
C3 A, B	1 μfd, 1μfd, 600 vdc, GE Pyranol	
C4	.025 μfd, 1000 vdc, GE Pyranol	
C5	0.5 μfd, 1000 vdc, GE Pyranol	
C6	0.6-.6-.6 μfd, 90 vdc, BuOrd Synchro Capacitor with brackets	
C7 A, B	1 μfd, 1μfd, 600 fdc, GE Pyranol	
C8	0.25 μfd, 1000 vdc, GE Pyranol	
C9	0.5 μfd, 1000 vdc, GE Pyranol	
C10 A thru X	225 μfd, 100 vdc, 24 units, 10 μfd each (2 units in series)	
B1	1CT Control Transformer, MK 5 MOD 3A, BuOrd, with MTG	
B2	1CT Control Transformer, MK 5 MOD 3A, BuOrd, with MTG	

APPENDIX A (Cont'd)

Part No.	Description	Replacement Check List
T1	L1262 (NRL 3695K) Interstage Transformer	
T2	L1262 (NRL 3695K) Interstage Transformer	
T3	KS8774 Western Electric Fil. Transformer	
T4	464-001-161 Jefferson Fil. Transformer	
M1	50-0-50 μA Weston Model 301	
S1	11-Position Rotary Switch (Limited to 7 positions) Nonshorting	
S2	DPST Toggle Switch Bat Handle, 3 A, 125 V	
S3	DPST Toggle Switch Bat Handle, 3 A, 125 V	
S4	DPST Toggle Switch Bat Handle, 3 A, 125 V	
S5	DPST Toggle Switch Bat Handle, 3 A, 125 V	
K1	Relay Clare Type A 13751 DC, with cover	
K2	Relay Leach 737 PS AC	
K3	Relay Leach 737 PS AC	
K4	Relay Leach 737 PS AC	
K5	Relay Cramer CF2 Time Delay	
K6	Relay Leach 737 PS AC	
K7	Relay Leach 737 PS AC	
K8	Relay Leach 737 PS AC	
K9	Relay Clare Type A 13751 DC, with cover	
V1	5726 Vacuum Tube, with shield	
V2	5691 Vacuum Tube, with clamp	
V3	5691 Vacuum Tube, with clamp	
V4	5691 Vacuum Tube, with clamp	
V5	5691 Vacuum Tube, with clamp	
V6	5726 Vacuum Tube, with shield	
V7, V8, V9, V10	NE-16 Vacuum Tube	
XK1, XK2, XK3, XK4, etc.	12 Octal Sockets for K1, K2, K3, K4, K6, K7, K8, K9. V2, V3, V4, V5	
X7, X8, X9, X10	4 Bayonet Sockets for V7, V8, V9, V10	
X1, X6	2 7-pin Miniature Sockets - National - for V1 and V6	
TB1	Terminal Strip, 17 terminal, Jones	
TB2	Terminal Strip, 17 terminal, Jones	
E1	1 Mtg Board for resistors	
O1, O2	2 Condenser mfg. plates for C1 and C10, with 12 mfg. studs	
O3	1 Relay clamping plate for K2, K3, K4, K6, K7, K8, with 6 mfg. studs	
I1	Lamp with socket and bezel, green, 115 v, 7 w	
I2	Lamp with socket and bezel, green, 115 v, 7 w	
I3	Lamp with socket and bezel, green, 115 v, 7 w	
I4	Lamp with socket and bezel, green, 115 v, 7 w	
F1	Little fuse (MTG. ON M1), 1/200 AMP.	
E1	Chassis, Panel, Brackets (Assembly) with Nameplates	

APPENDIX A (Cont'd)

Part No.	Description	Replacement Check List
Remote Control Box		
I1	Lamp with socket and bezel, green, 115 v, 7 w	
I2	Lamp with socket and bezel, red, 115 v, 7 w	
S1	DPTT Toggle Switch	
TB-1	Terminal Strip, 7 terminals, Jones	

* * *

LOCATION – AN/CP-191(XB-1)/SPG Computer-Tracker, Radar Unit for Gun Fire Control Radar Mk 25 Mod 2			JUNCTION POINT TB-1		
Terminal	Function	From	Term.	Color	Cable
TB-1 1	R1 - Synchro Rotor Buss	F. C. Switchboard		Black	#1 MHFF-10
2	R2 - Synchro Rotor Buss	F. C. Switchboard		White	#1 MHFF-10
3	S3 } 72,000 yds/rev Range	F. C. Switchboard		Red	#1 MHFF-10
4	S2 } Synchro Stators	F. C. Switchboard		Green	#1 MHFF-10
5	S1 } Synchro Stators	F. C. Switchboard		Orange	#1 MHFF-10
6	S3 } Director Elevation 2X	F. C. Switchboard		Blue	#1 MHFF-10
7	S2 } Synchro Stators	F. C. Switchboard		White-Black	#1 MHFF-10
8	S1 } Synchro Stators	F. C. Switchboard		Red-Black	#1 MHFF-10
9	115 volts ac (Out)	Computer	1	Black	#2 MHFF-10
10	Train B/W* & Limiting Indicator	Remote	2	White	#2 MHFF-10
11	Elev. B/W Indicator	Control	N.C.*		#2 MHFF-10
12	Elev. Limiting Indicator	Control	3	Green	#2 MHFF-10
13	Elev. Switch Common	Control	4	Orange	#2 MHFF-10
14	Train B/W & Limiting Switch	Control	5	Blue	#2 MHFF-10
15	Elev. B/W Switch	Control	6	White-Black	#2 MHFF-10
16	Elev. Limiting Switch	Control	7	Red-Black	#2 MHFF-10
17	E+R By-Pass Indicator	Control	N.C.		#2 MHFF-10

* N.C. = No connection; B/W = Bandwidth

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APPENDIX B
Cabling Data (Cont'd)

LOCATION - AN/CP-191(XB-1)/SPG Computer-Tracker, Radar Unit for Gun Fire Control Radar Mk 25 Mod 2					JUNCTION POINT TB-2	
Terminal		Function	From	Term.	Color	Cable
TB-2	1	E + R By-Pass Switch		N.C.		
	2	115 Volts acc (Out)		N.C.		
	3	115 Volts acc (In)	Unit #12	91-99	Green, Yellow	#3 MCOS-6
	4	115 Volts ac (In)	Unit #12	100-108	Black, Red #2	#3 MCOS-6
	5	GND. (Power Supply)	Unit #12	49-57	Shield #1	#3 MCOS-6
	6	-300 Volts (@ 20 Ma)	Unit #12	59-64	White #1	#3 MCOS-6
	7	Auto Elev. Enabling 115 Volts	Unit #17	20	Green, Yellow	#4 MCOS-6
	8	Auto Train Enabling 115 Volts	Unit #17	19	Green, Yellow	#5 MCOS-6
	9	Elev. Signal G'nd.	Unit #17	16	Shield #1 and #2	#4 MCOS-6
	10	Elev. Error Rate Signal	(17A1)	3	Black, Red #2	#4 MCOS-6
	11	Elev. Parallel-T	(17A1) Z1	3	White #1	#4 MCOS-6
	12	Elev. Error Signal	Unit #17	15	Black #1	#4 MCOS-6
	13	Train Signal Ground	Unit #17	13	Shield #1 and #2	#5 MCOS-6
	14	Train Error Rate Signal	(17A2)	3	Black, Red #2	#5 MCOS-6
	15	Train Parallel-T	(17A2)Z1	3	White #2	#5 MCOS-6
	16	Train Error Signal	Unit #17	14	Black #1	#5 MCOS-6
	17	+300 Volts (@ 20 Ma)	Unit #12	75-77	Black #1	#3 MCOS-6

APPENDIX B
Cabling Data (Cont'd)

Wire No.	Color	From CP-191		To F. C. S-B	Function
1	Black	TB-1	1		R1 Synchro Rotor Buss
2	White	TB-1	2		R2 Synchro Rotor Buss
3	Red	TB-1	3		S3 72,000 Yd/Rev. Range Synchro Stators
4	Green	TB-1	4		S2 72,000 Yd/Rev. Range Synchro Stators
5	Orange	TB-1	5		S1 72,000 Yd/Rev. Range Synchro Stators
6	Blue	TB-1	6		S3 2X Elevation Synchro Stators
7	White-Black	TB-1	7		S2 2X Elevation Synchro Stators
8	Red-Black	TB-1	8		S1 2X Elevation Synchro Stators
9	Green-Black	TB-1	9		Spare
10	Orange-Black	TB-1	10		Spare
Connection		TB-1 CP-191(XB-1)/SPG to Fire Control Switchboard			Cable No. 1
Cable Type		MHFF-10(MHFA-10)			

APPENDIX B
Cabling Data (Cont'd)

Wire No.	Color	From	To	Function
1	Black	AN/CP-191 (XB-1) SPG TB-1 9	COMPUTER/DIRECTOR REMOTE CONTROL 1	115 A.C.
2	White	10	2	Train Limiting + B/W Indicator
3	Red			Spare
4	Green	12	3	Elev. Limiting Indicator
5	Orange	13	4	Elev. Switch Common
6	Blue	14	5	Train Limiting + B/W Switch
7	White-Black	15	6	Elev. Bandwidth Switch
8	Red-Black	16	7	Elev. Limiting Switch
				Spare
				Spare

Connection	TP-1 CP-191(XB-1)/SPG to Computer/ Director Remote Control	Cable No. 2
Cable Type	MHFF-10	

APPENDIX B
Cabling Data (Cont'd)

Wire No.	Color	From	To	Function
1	Black	TB-2 17	Unit #12 75-77	300@ 20 ma
2	White	TB-2 6	Unit #12 58-64	-300 @20 ma
3	Shield #1	TB-2 5	Unit #12 49-57	Pwr. Supply GND
4	Black	TB-2 4	Unit #12	
5	Red	TB-2 4	Unit #12 100-108	115 A. C.
6	Shield #2	TB-2 N. C.	Unit #12	N. C.
7	Green	TB-2 3	Unit #12 91-99	115 A. C. C.
8	Yellow	TB-2 3	Unit #12	
		CP-191 (XB-1)/SPG Computer-Tracker Radar	MK 25 MOD 2 F. C. Radar	

Connection	CP-191(XB-1)/SPG to Radar Mk 25 Mod 2 Unit #12	Cable No. 3
Cable Type	MCOS-6	

APPENDIX B
Cabling Data (Cont'd)

Wire No.	Color	From		To		Function
1	Black	TB-2	12	Unit #17	15	Elevation Error Signal
2	White	TB-2	11	(17A1)* Z1	- 3	Elevation Parallel-T
3	Shield #1	TB-2	9	Unit #17	16	Elevation Signal GND
4	Black	TB-2	10	(17A1) †	3	Elevation Error Rate Signal
5	Red	TB-2	10	(17A1)	3	Elevation Error Rate Signal
6	Shield #2	TB-2	9	Unit #17	16	Elevation Signal GND
7	Green	TB-2	7	Unit #17	20	Elevation Auto Enabling Relay
8	Yellow	TB-2	7	Unit #17	20	115 A.C.
		CP-191 (XB-1)/SPG Computer-Tracker Radar		MK 25 Mod F. C. Radar	2	

* Direct Connection to (17A1) Z1 Term #3.
† Connection to Unit 17A1 (Elev. Servo Amplifier Term #3).

Connection	CP-191(XB-1)/SPG to Radar Mk 25 Mod 2 Tracker Unit #17	Cable No. 4
Cable Type	MCOS-6	

APPENDIX B
Cabling Data (Cont'd)

Wire No.	Color	From		To		Function
1	Black	TB-2	16	Unit #17	14	Train Error Signal
2	White	TB-2	15	(17A2)* Z1	3	Train Parallel-T
3	Shield	TB-2	13	Unit #17	13	Train Signal GND
4	Black	TB-2	14	17A2 †	3	Train Error Rate Signal
5	Red	TB-2	14	17A2	3	Train Error Rate Signal
6	Shield	TB-2	13	Unit #17	13	Train Signal GND
7	Green	TB-2	8	Unit #17	19	Train Auto Enabling Relay
8	Yellow	TB-2	8	Unit #17	19	115 A.C.
		CP-191 (XB-1)/SPG Computer-Tracker Radar		MK 25 MOD 2 F. C. Radar		

* Direct Connection to Component (17A2) Z1 Term #3.
† Connection to Unit 17A2 (Train Servo Amplifier) Term #3.

Connection	CP-191(XB-1)/SPG to Radar Mk 25 Mod 2 Tracker Unit #17	Cable No. 5
Cable Type	MCOS-6	

* * *

APPENDIX C
Equipment Photographs

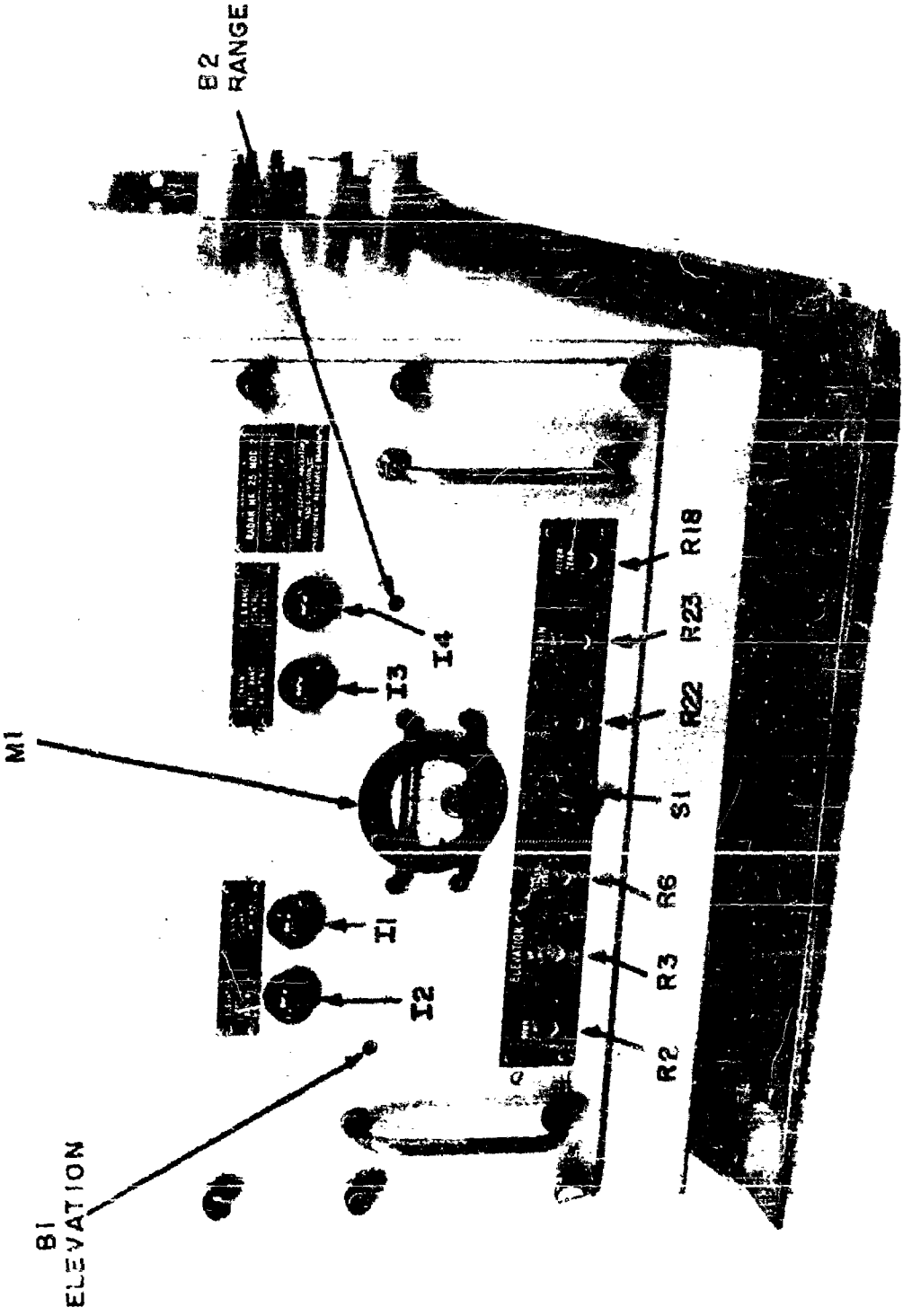


Fig. 1 - AN/CP-191 (XB-1)/SPG Computer-Tracker, Radar Unit (front view)

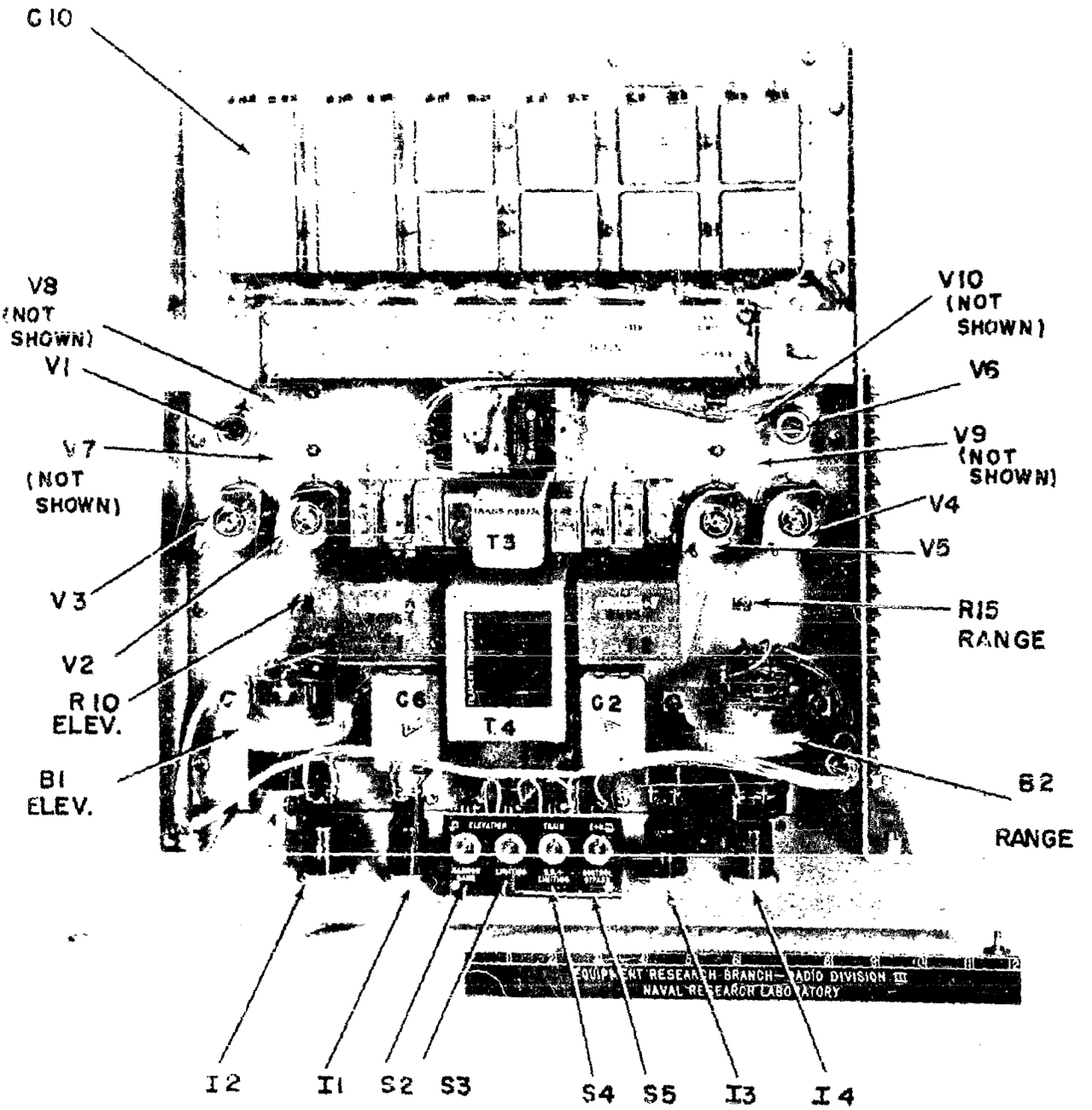


Fig. 2 - AN/CP-191 (XB-1)/SPG Computer-Tracker, Radar Unit (top view)

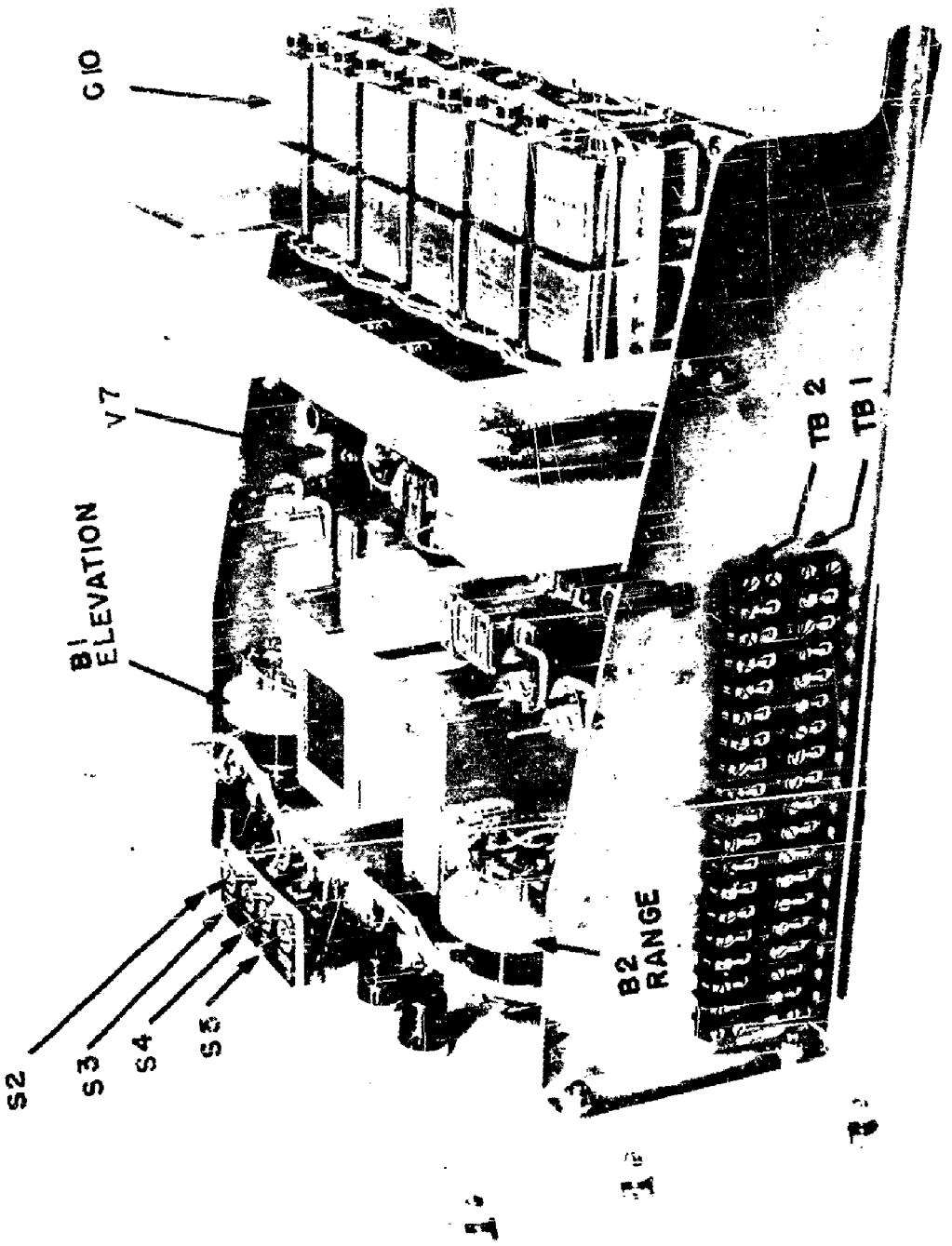


Fig. 3 - AN/CP-191 (XB-1)/SPG Computer-Tracker, Radar Unit (right-side view)

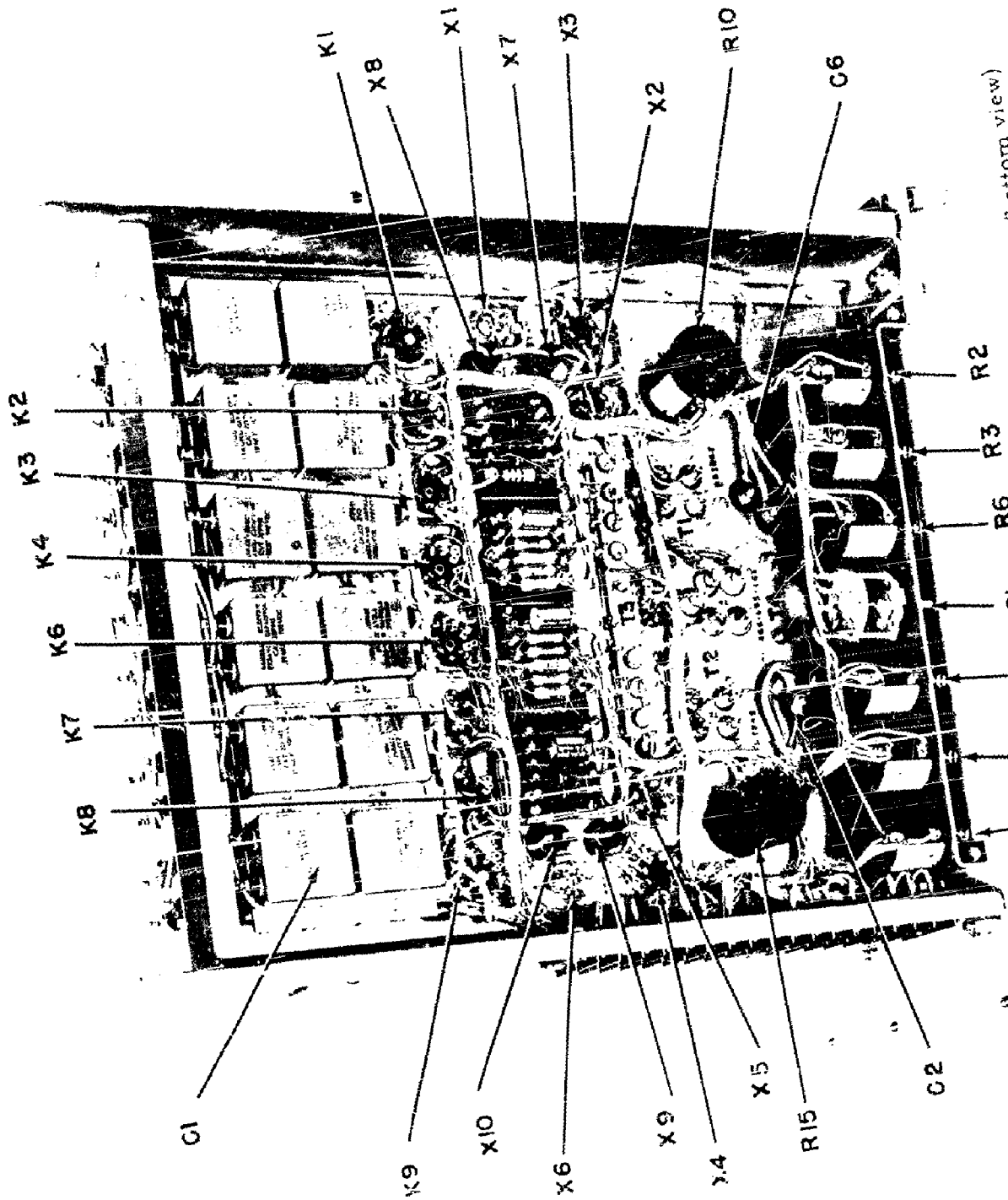


Fig. 4 - AN/CP-191 (XB-1)/SPG Computer-Tracker, Radar Unit (bottom view)

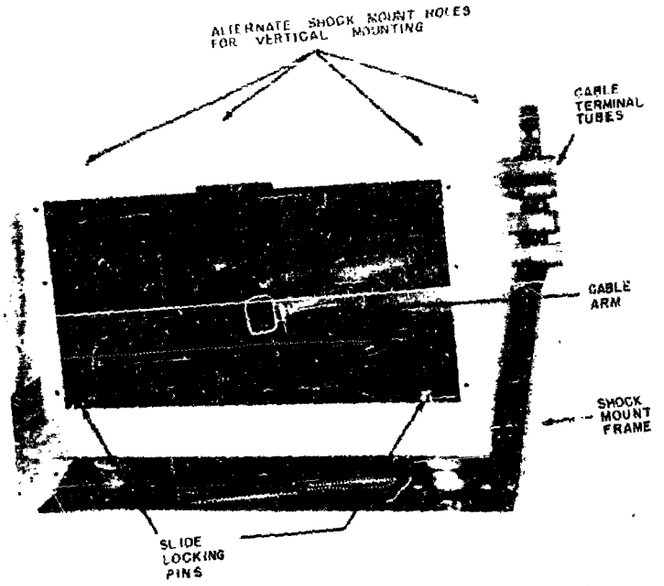


Fig. 5 - Cabinet for AN/CP-191 (XB-1)/SPG Computer-Tracker, Radar Unit (interior view)

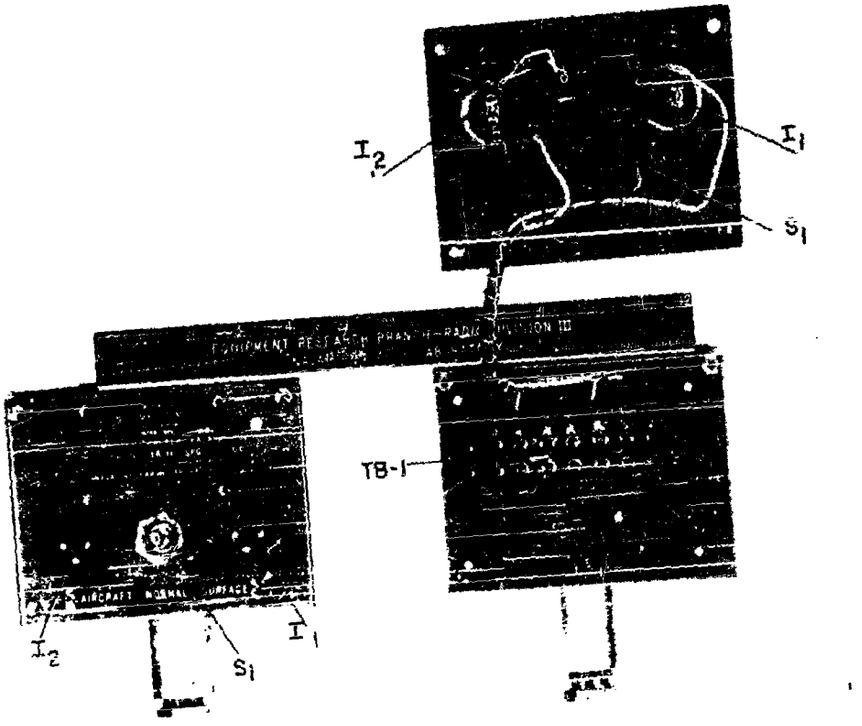
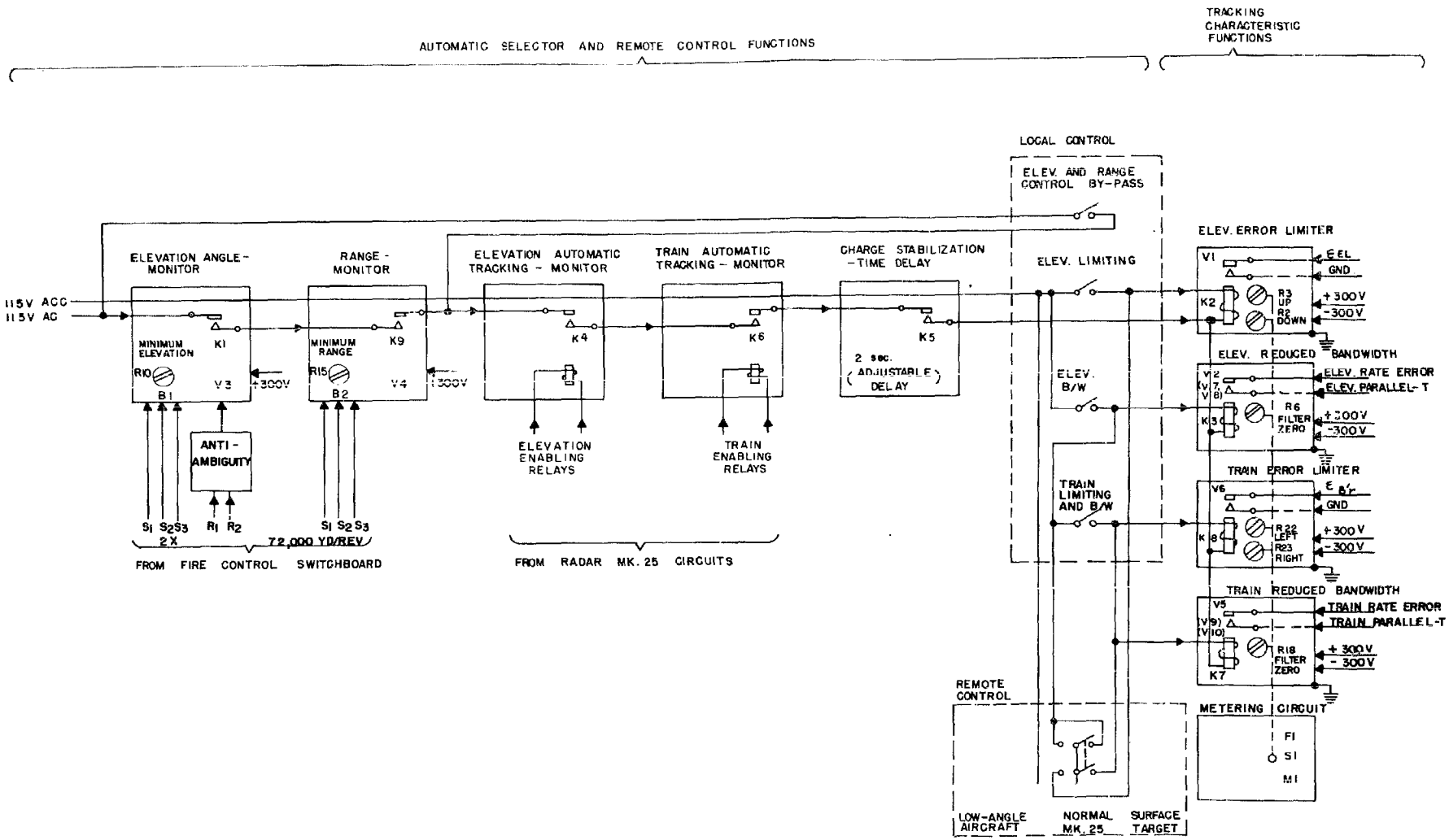


Fig. 6 Control Box for AN/CP-191 (XB-1)/SPG Computer-Tracker, Radar Unit (interior and exterior views)

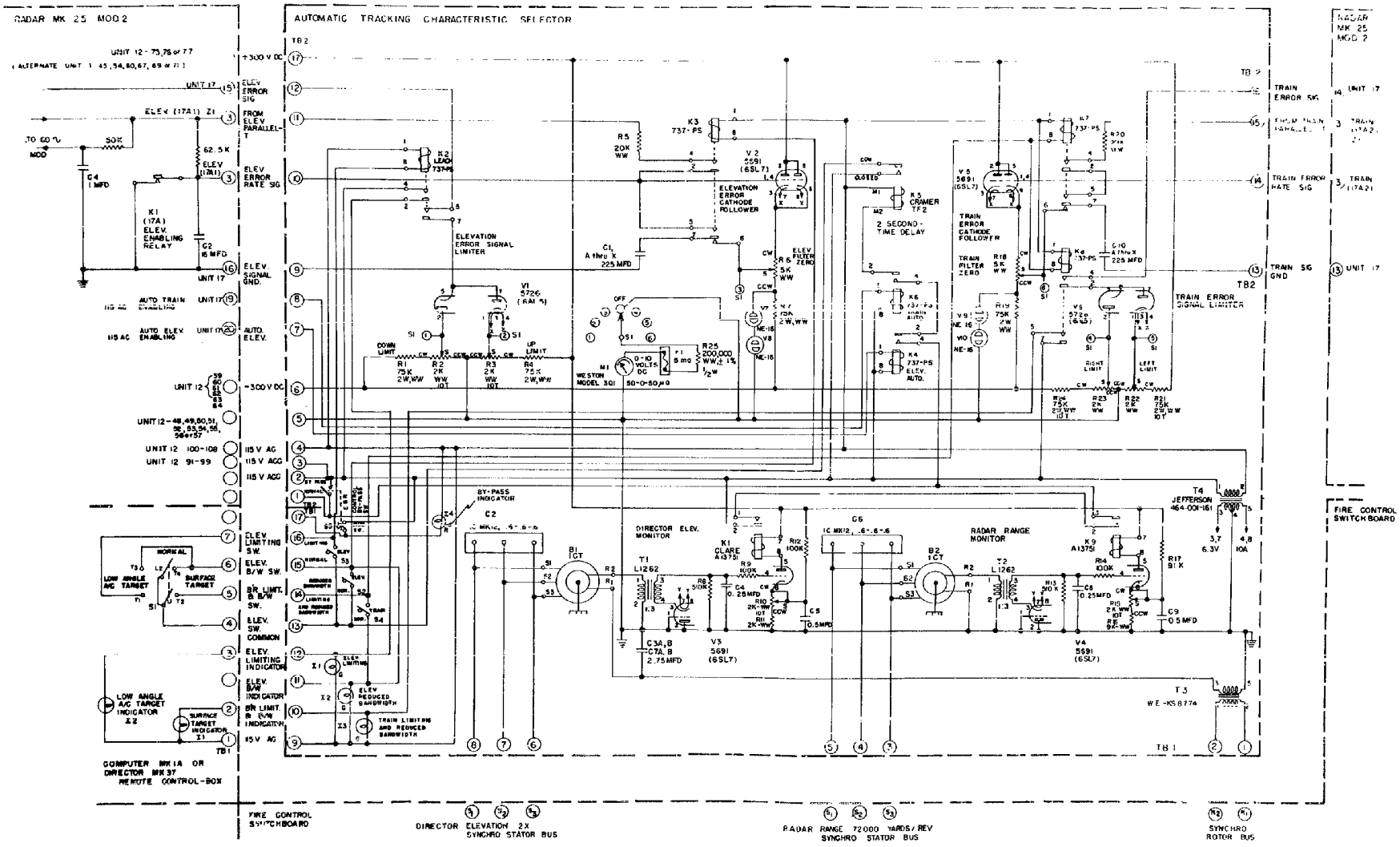
* * *

APPENDIX D
Plates

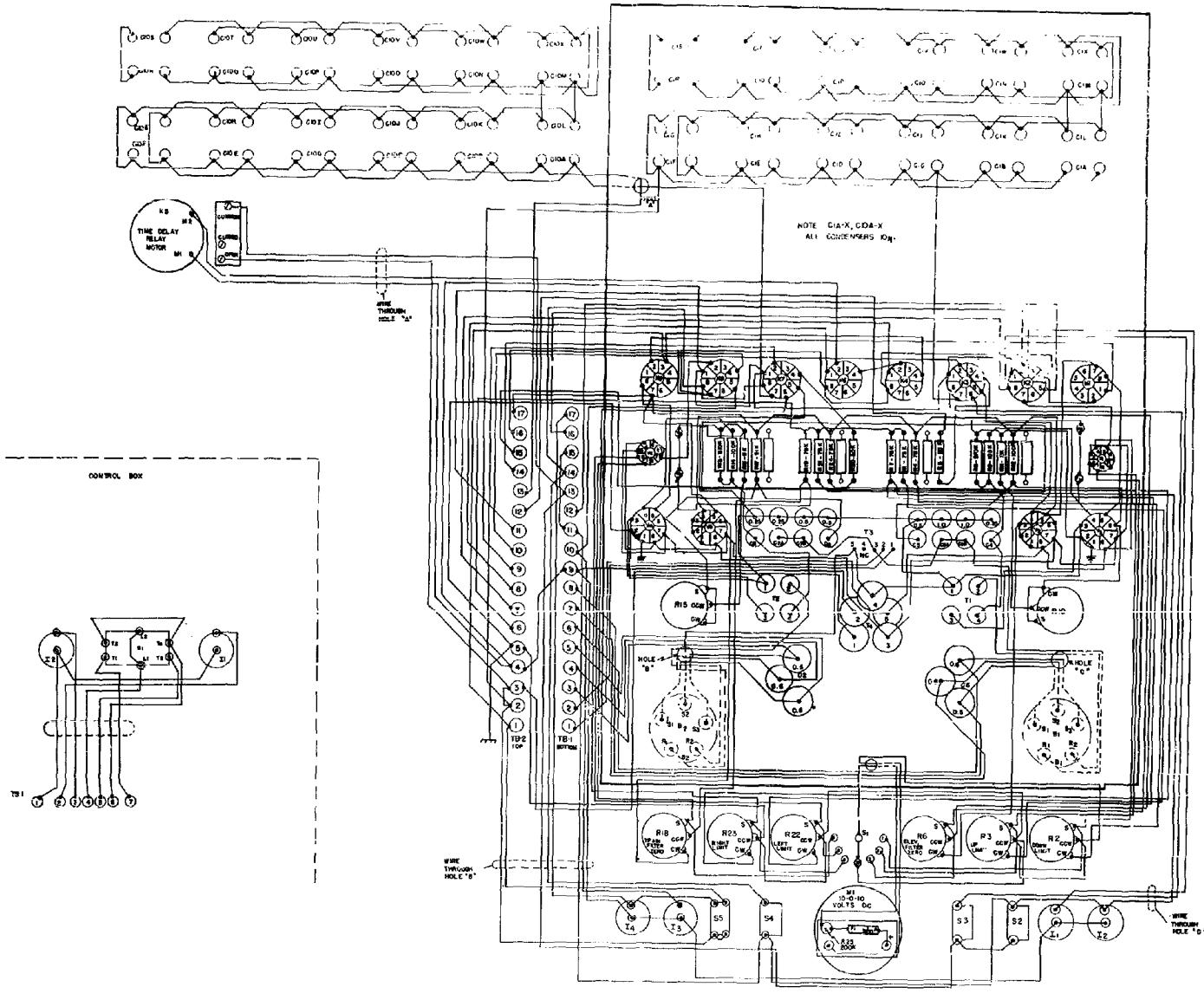
Drawing No.	Title	Plate No.
3666 C 4	Functional Diagram of AN/CP-191 (XB-1)/SPG	1
3666 D 1	Schematic Diagram of AN/CP-191 (XB-1)/SPG	2
3666 F 2	Wiring Diagram of AN/CP-191(XB-1)/SPG	3
3600 D 2948	Bottom View of Chassis of Control Unit	4
2678	Details of Chassis Blank	5
2680	Details of Chassis Blank	6
2679	Details of Chassis Blank	7
2677	Assembly Drawing of Chassis Blank	8
3600 D 2983	Rack and Mounting Bracket	9
3600 D 2984	Rack and Mounting Bracket	10
RA 10D 967	Assembly Drawing of Rack for Mobile Radar	11
RA 10D 967	Details of Rack for Mobile Radar	12
RA 10D 967	Details of Rack for Mobile Radar	13
RA 10D 967	Details of Rack for Mobile Radar	14
RA 10D 967	Details of Rack for Mobile Radar	15
1100-SP-1821	Mount for Size 1 Synchro	16
3600 A 2911	Clamp for 1-CT Synchro	17
3666 A-6	Meter-Face Protector	18
1100-SP-2368	Panel Handle	19
1100-SP-2369	Handle Bushing	20
3600 C 2914	Components for AN/CP-191 (XB-1)/SPG	21
3600 C 2947	Panel Detail	22
3600 C 2915	Components for AN/CP-191 (XB-1)/SPG	23
3600 C 2946	Components for AN/CP-191 (XB-1)/SPG	24



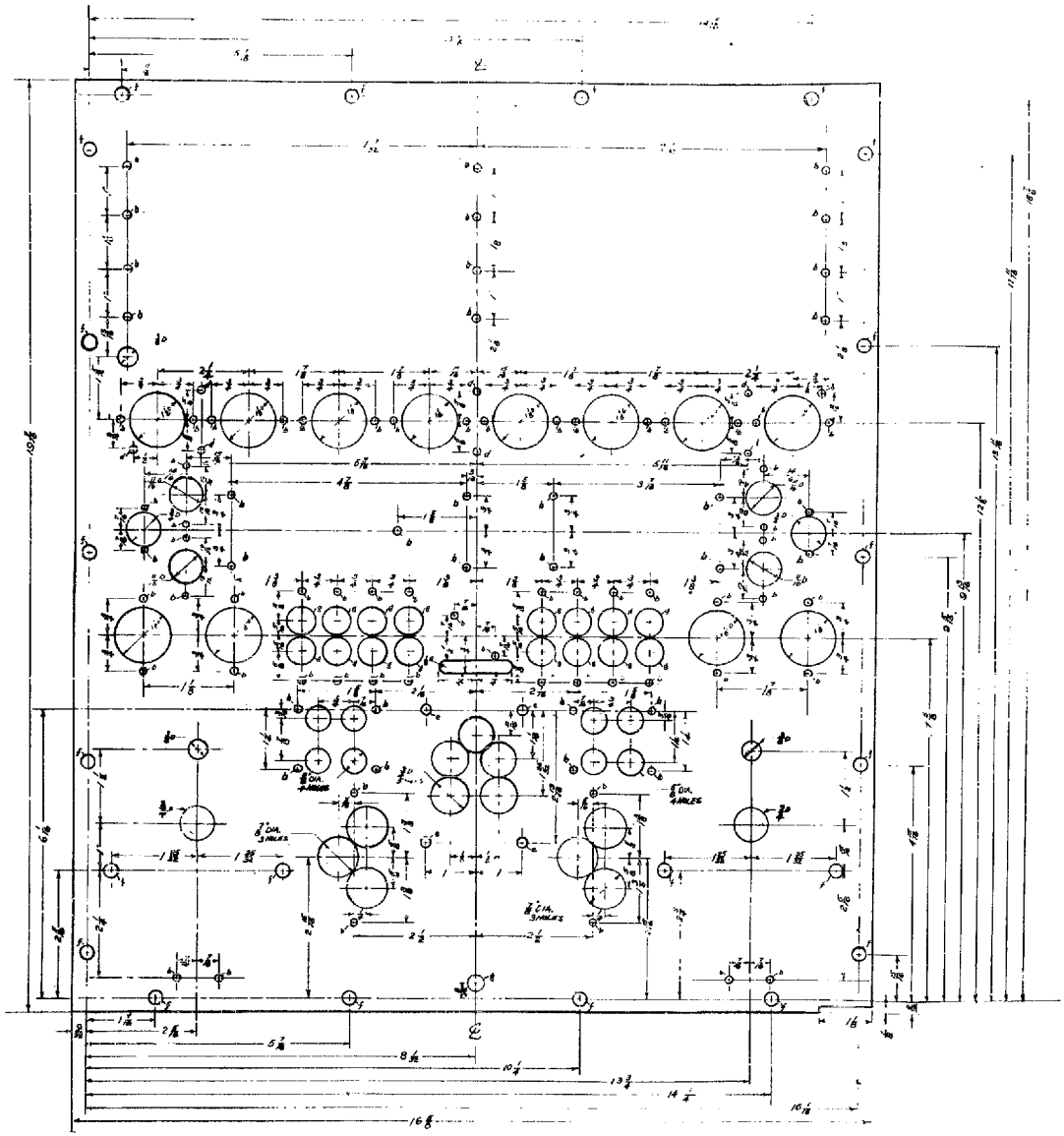
3666 C 4 - Plate 1 - Functional diagram of AN/CP-191 (XB-1)/SPG



3666 D 1 - Plate 2 - Schematic diagram of AN/CP-191 (XB-1)/SPG



3666 F 2 - Plate 3 - Wiring diagram of AN/CP-191 (XB-1)/SPG



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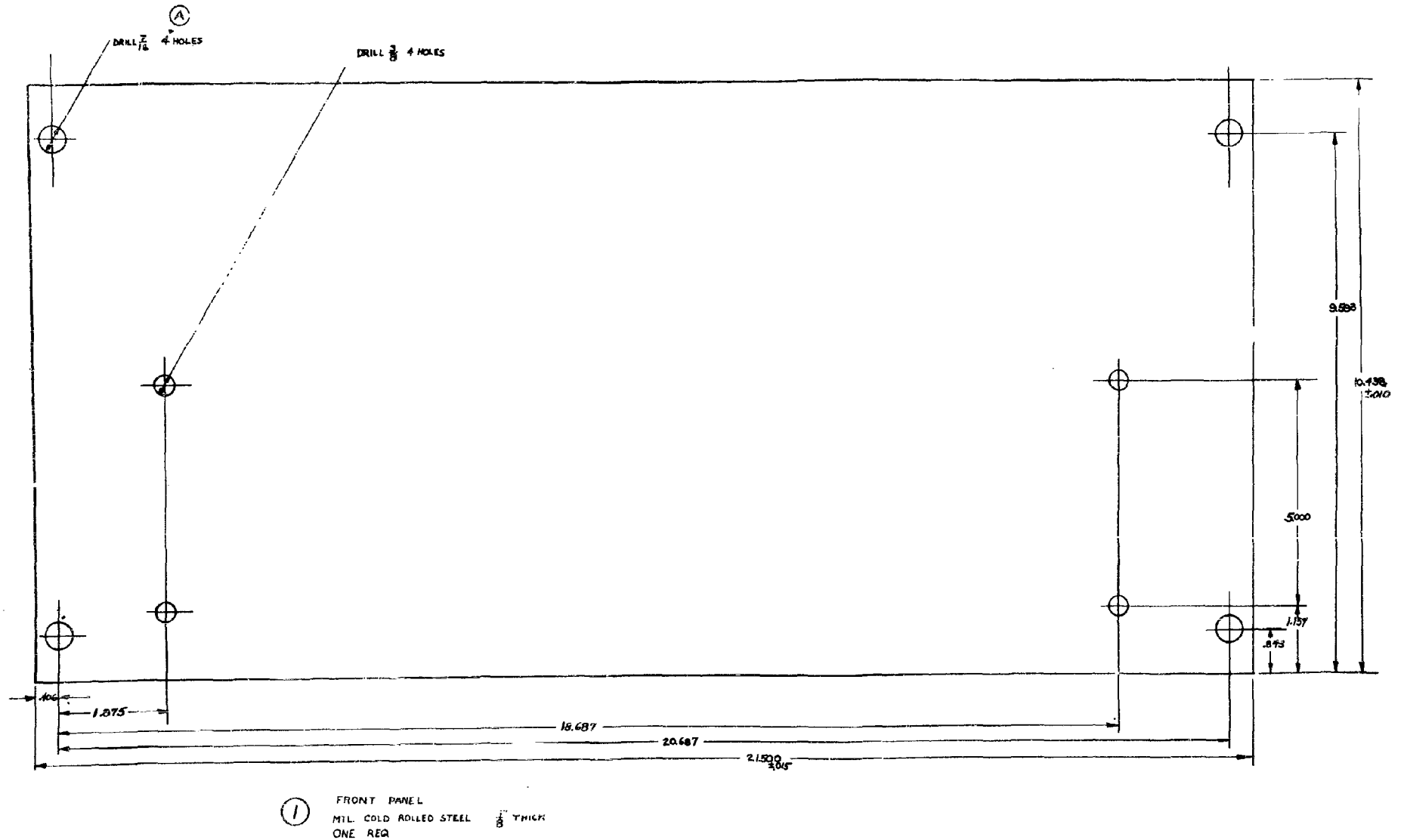
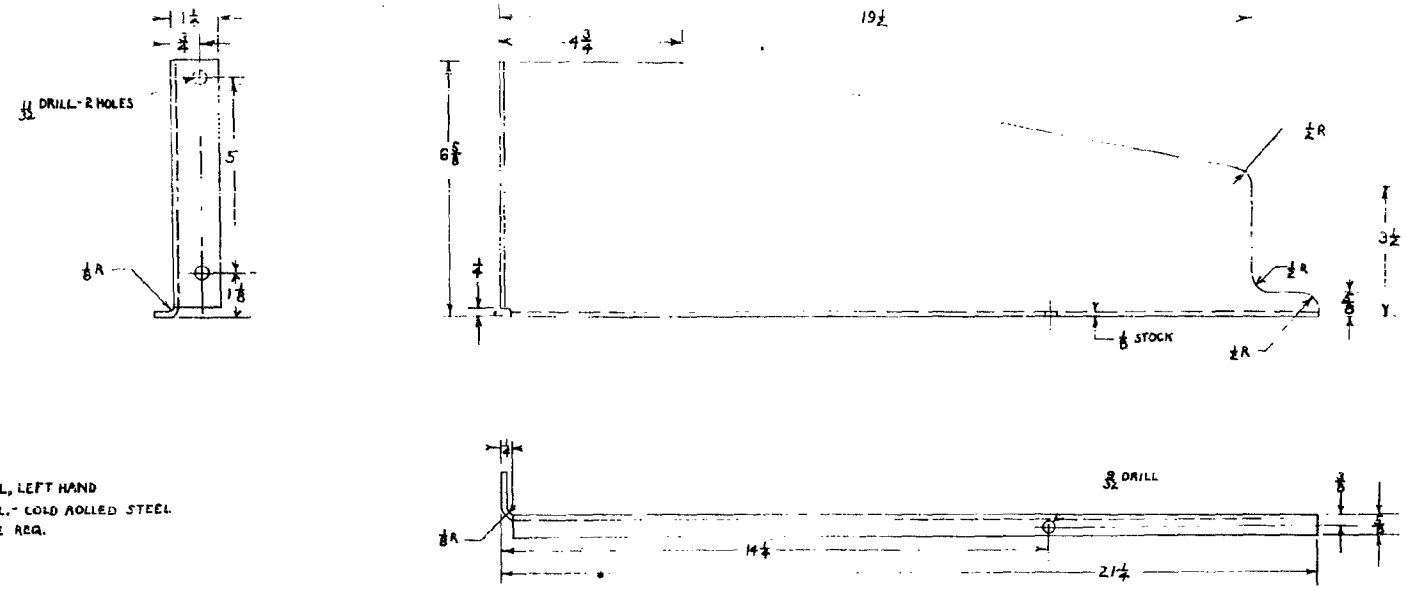
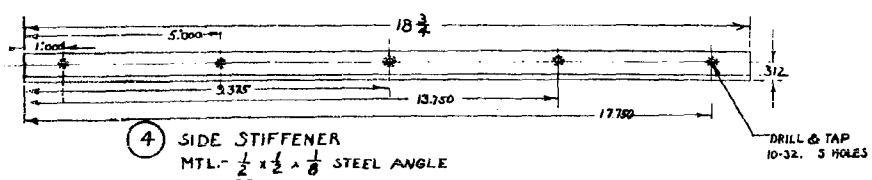
3600 D 2948 - Plate 4 - Bottom view of chassis of control unit



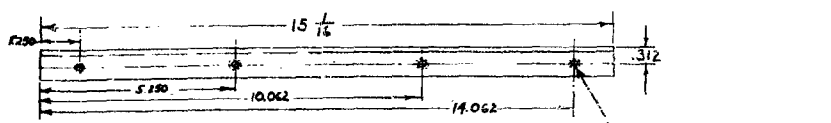
2678 - Plate 5 - Details of chassis blank



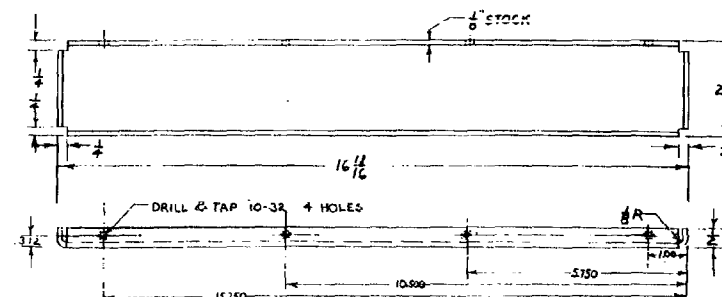
(3) RAIL, LEFT HAND
MTL.- COLD ROLLED STEEL
ONE REQ.



(4) SIDE STIFFENER
MTL.- ½ x ½ x ⅛ STEEL ANGLE
TWO REQ.

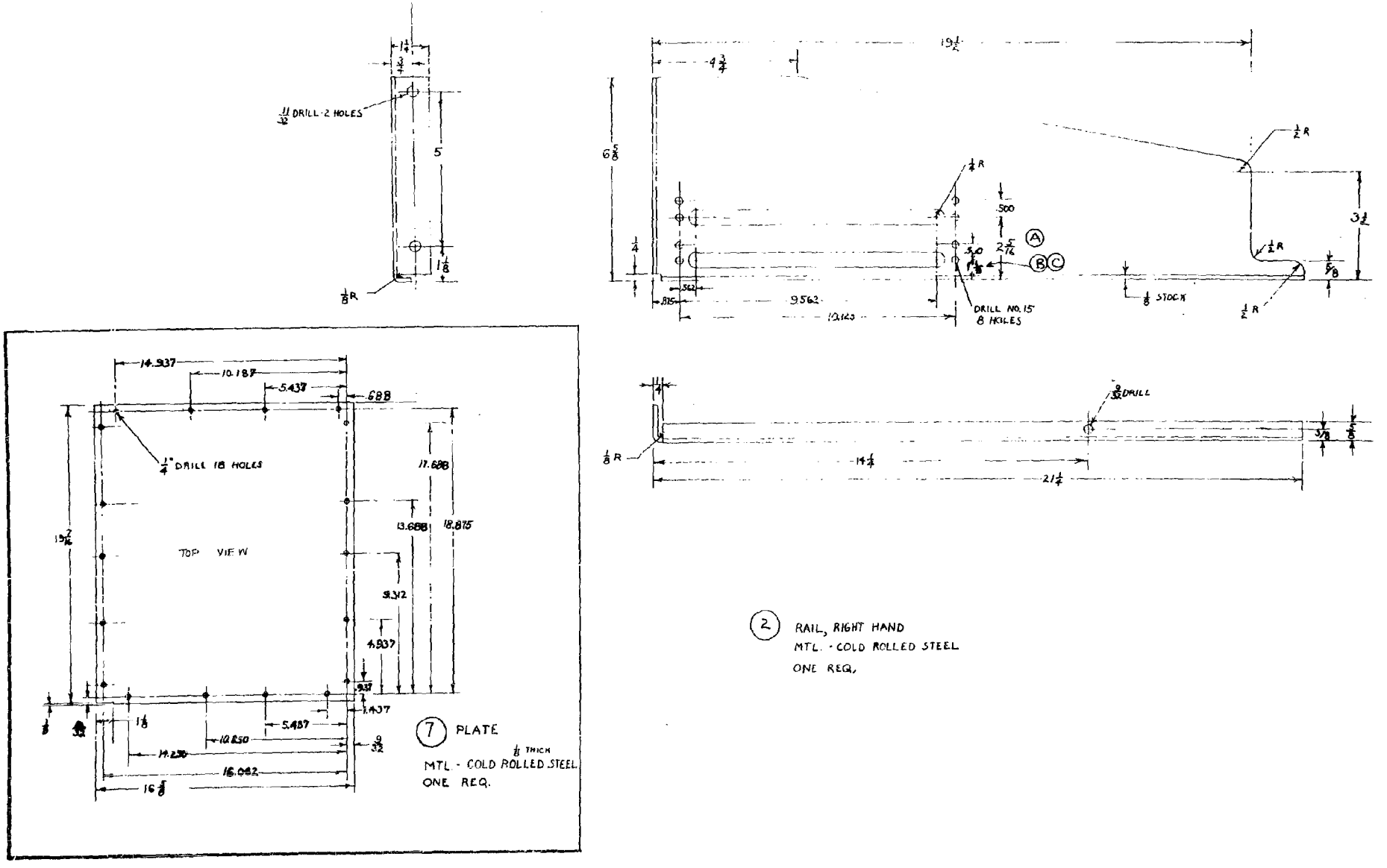


(5) FRONT STIFFENER
MTL.- ½ x ½ x ⅛ STEEL ANGLE
ONE REQ.

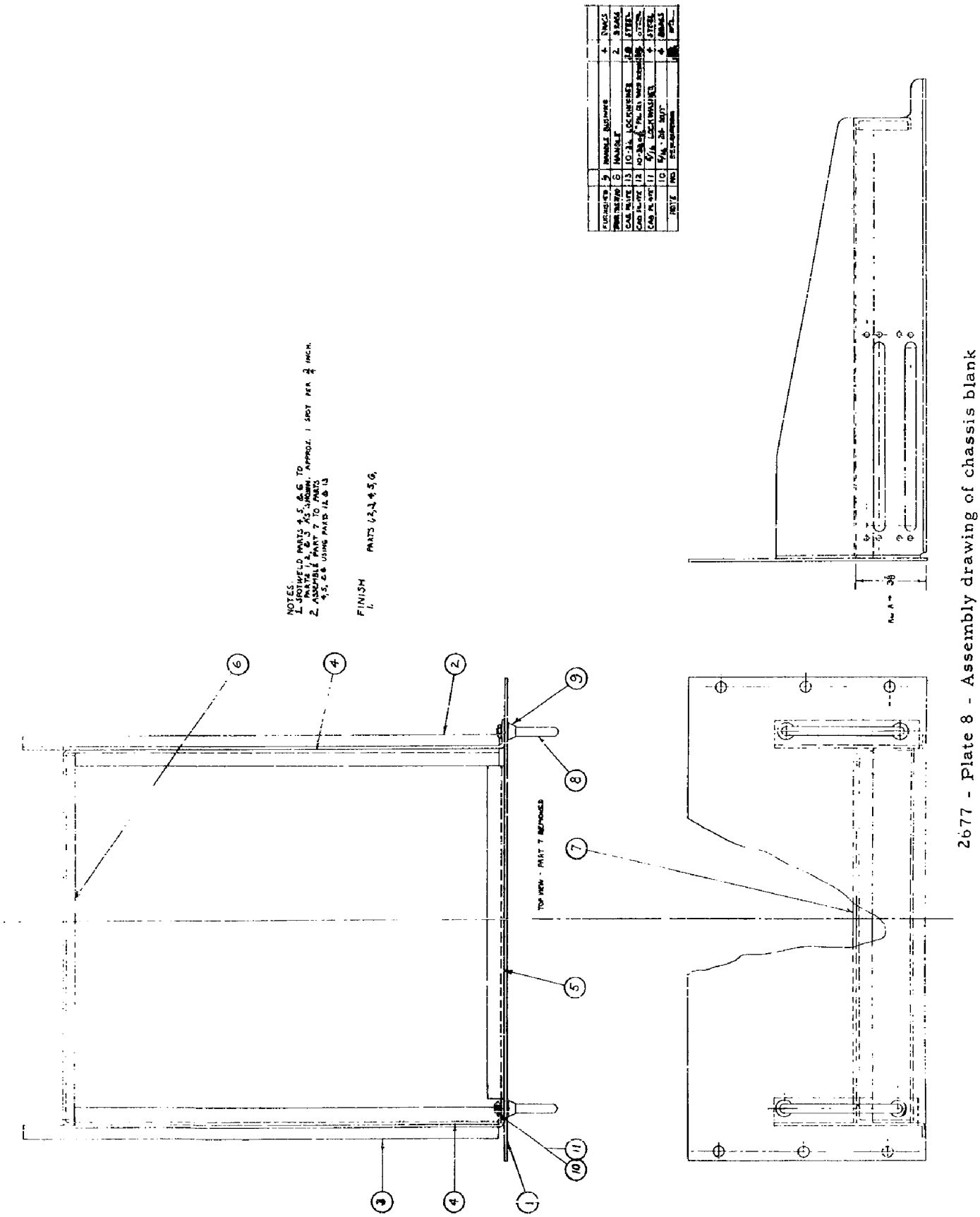


(6) REAR STIFFENER
MTL.- COLD ROLLED STEEL
ONE REQ.

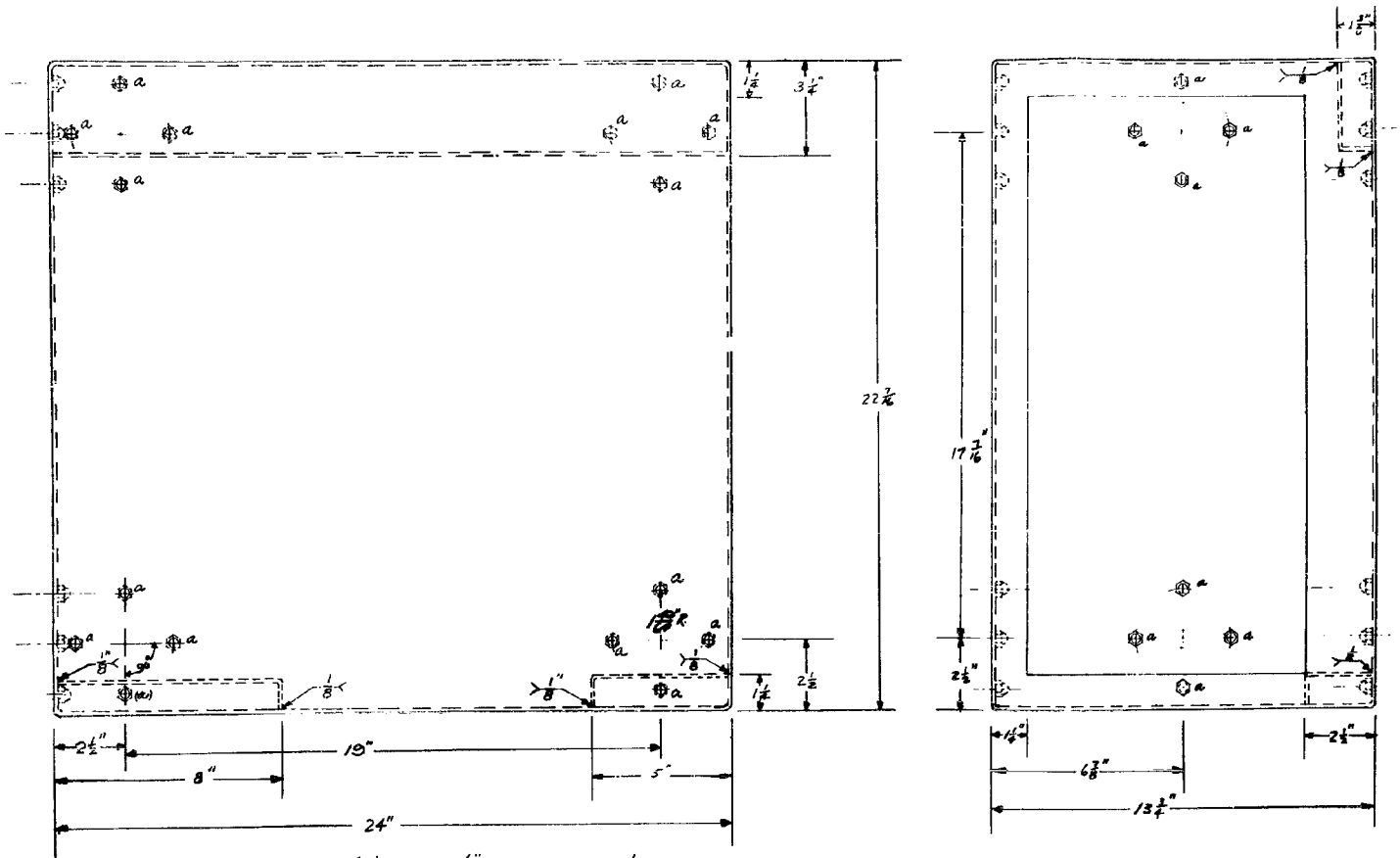
2680 - Plate 6 - Details of chassis blank



2679 - Plate 7 - Details of chassis blank



2677 - Plate 8 - Assembly drawing of chassis blank

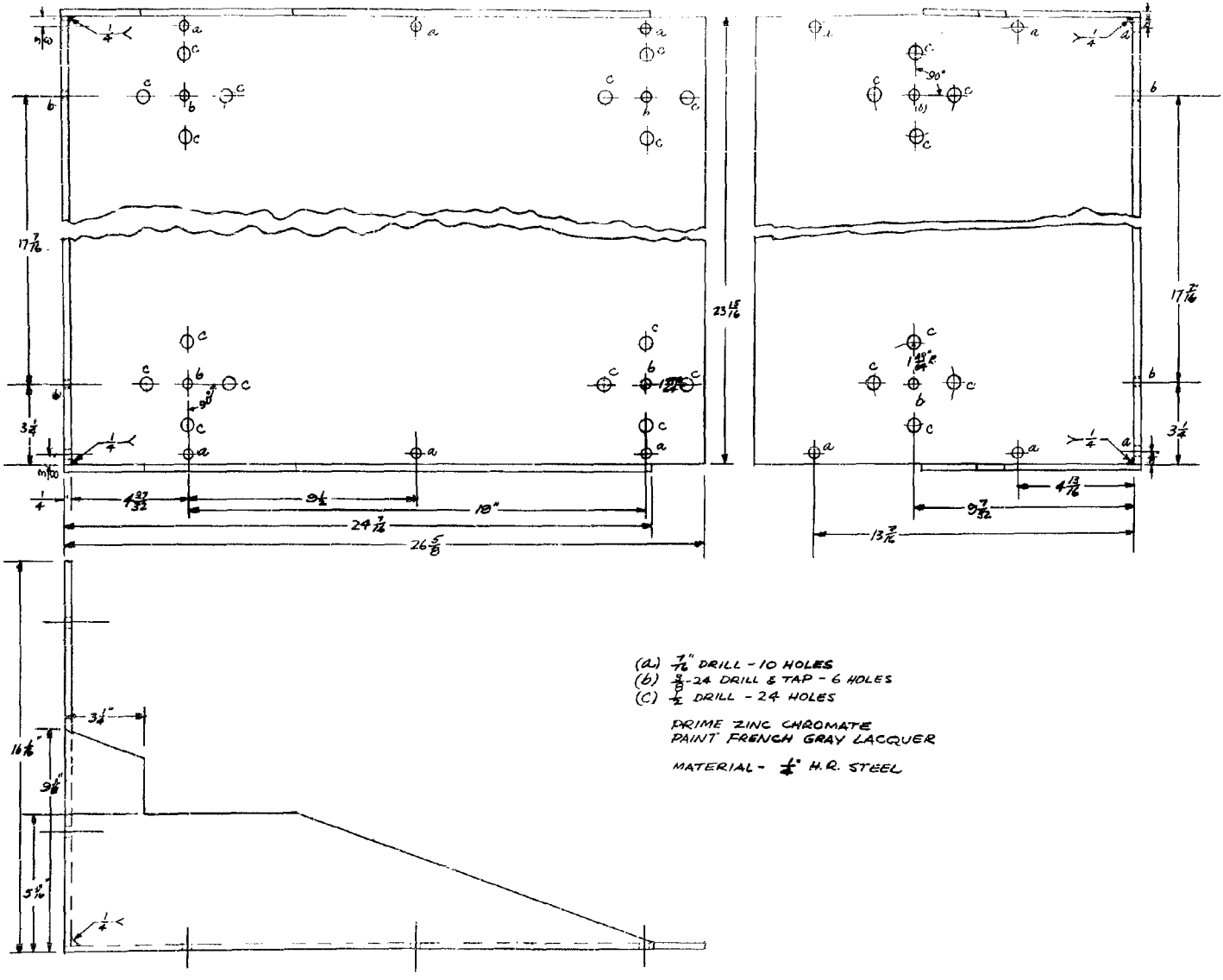


(a) DRILL 1/4" HOLE. CENTER 1/4-20 ACORN NUTS ON INSIDE OF HOLE & WELD OR SILVER SOLDER. 40 HOLES

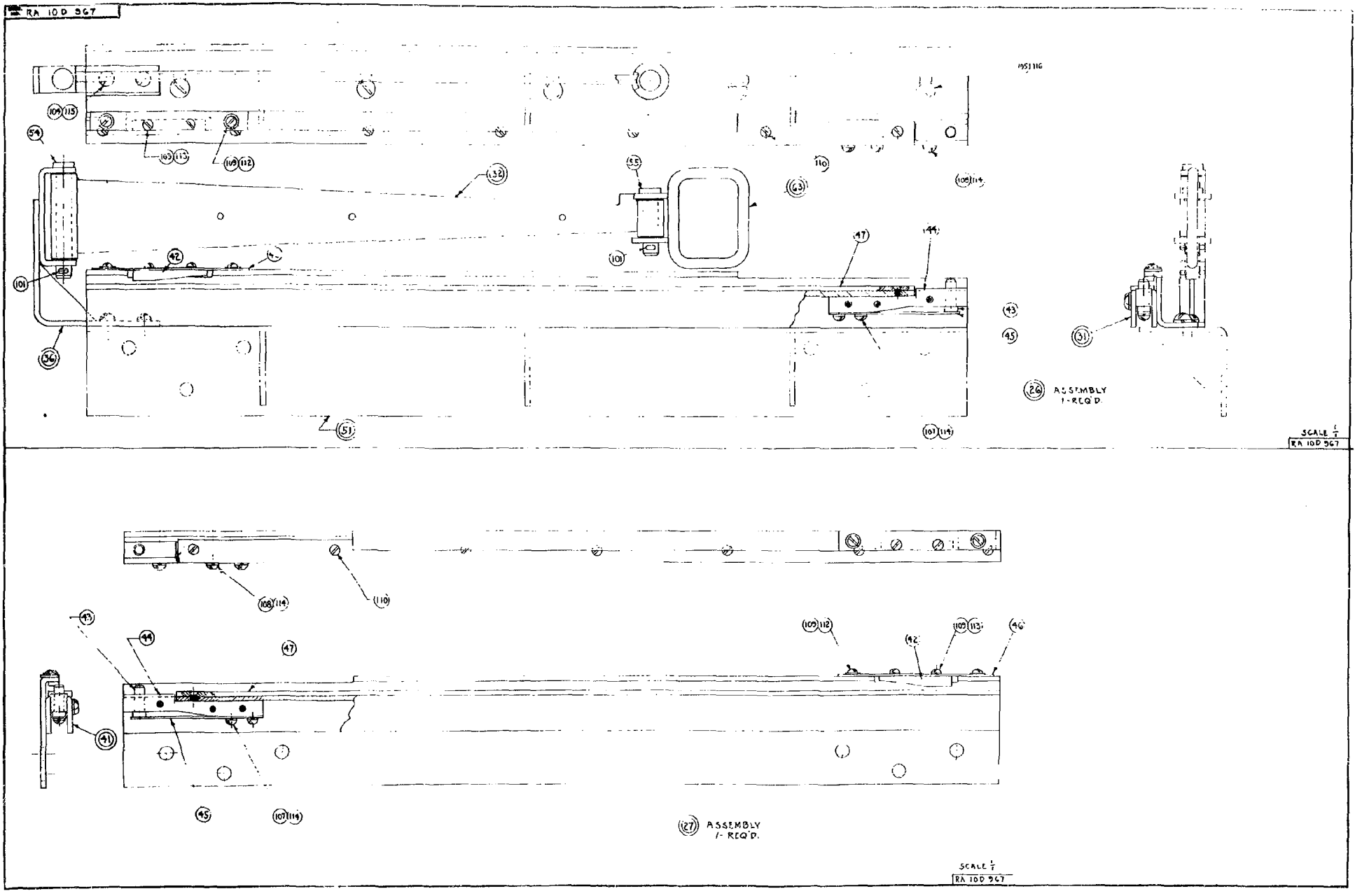
PRIME ZINC CHROMATE. PAINT FRENCH GRAY LACQUER

MATERIAL - 1/8" C.R. STEEL SHEET

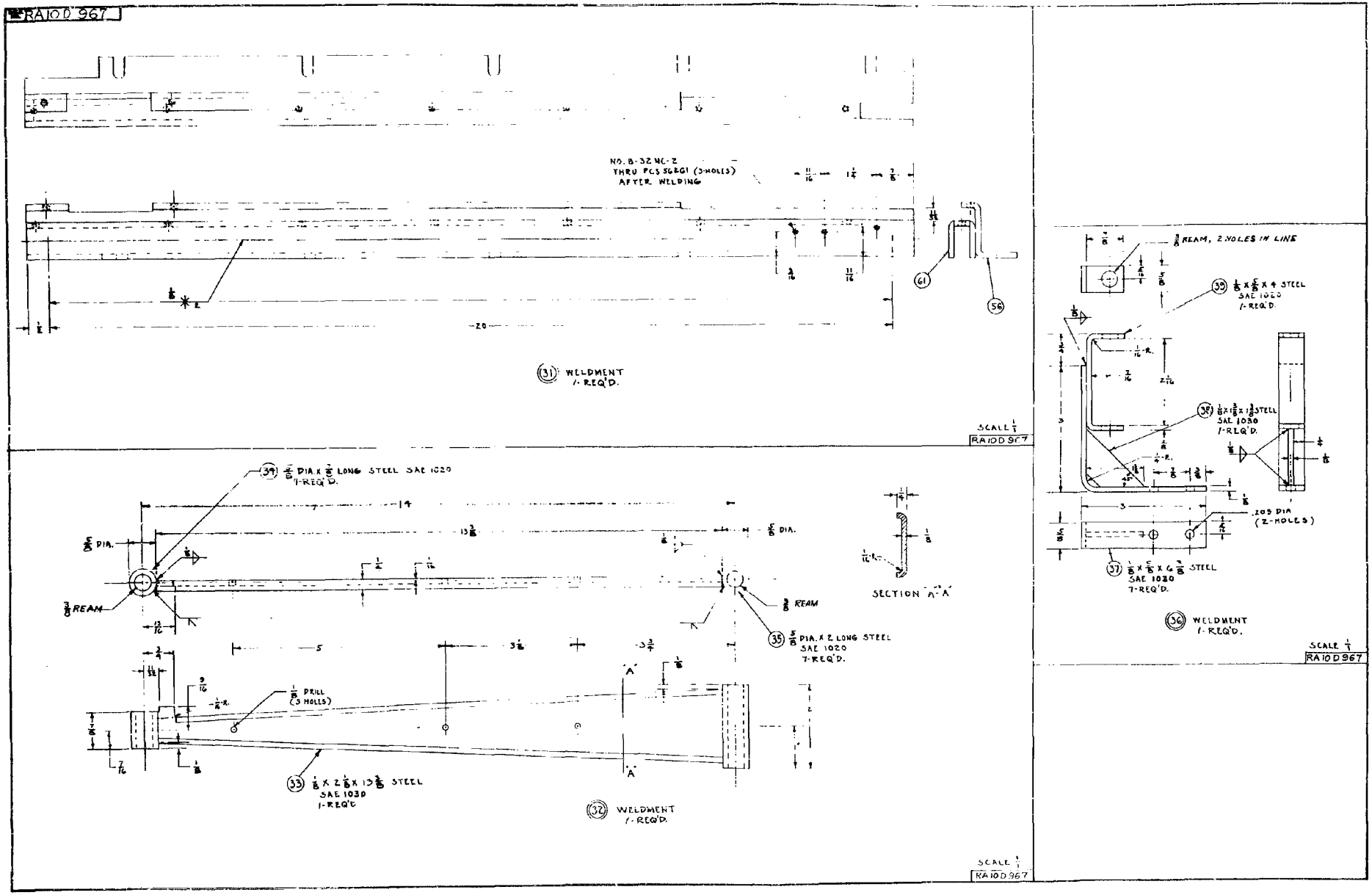
3600 D 2983 - Plate 9 - Rack and mounting bracket



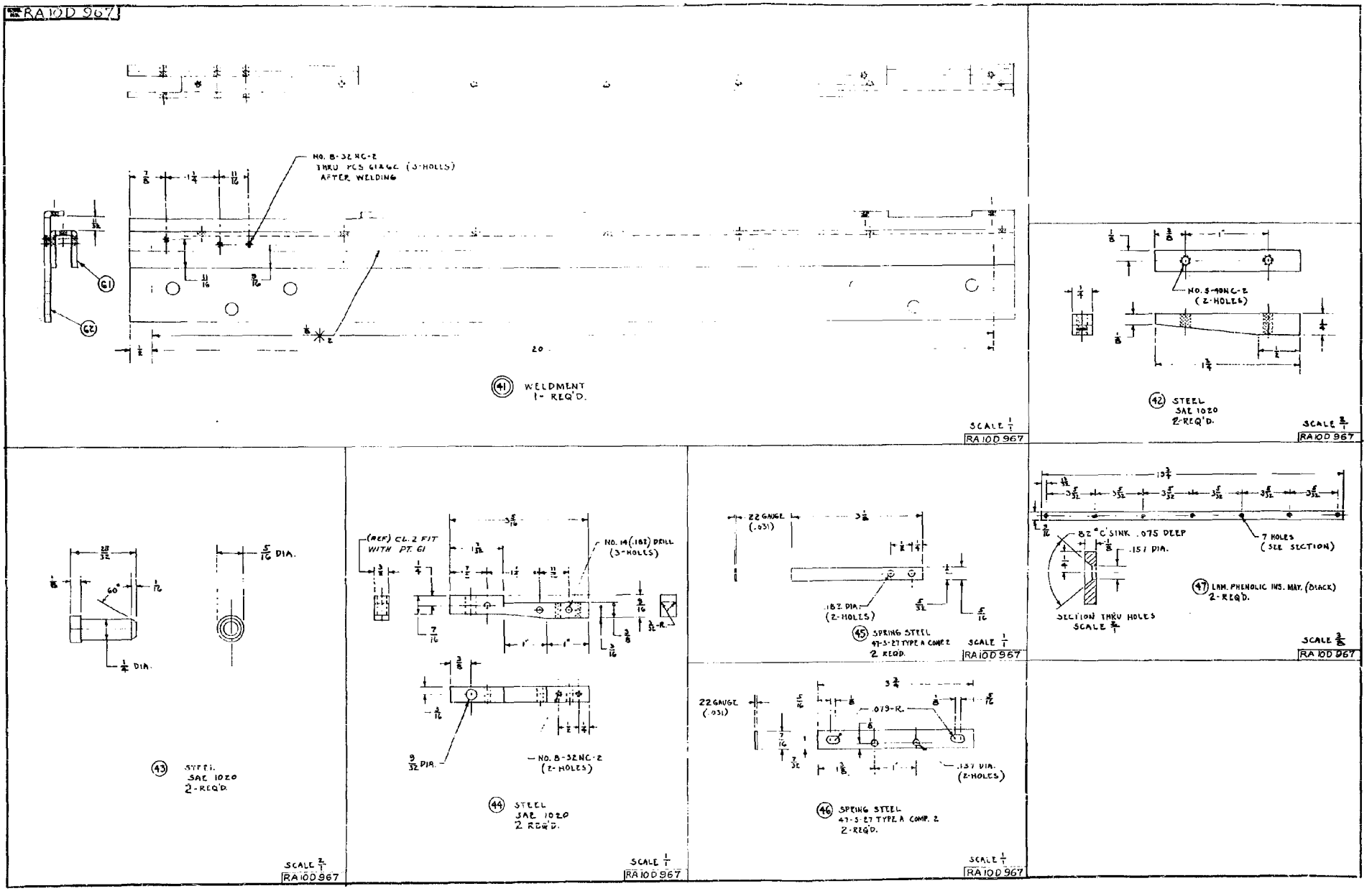
3600 D 2984 - Plate 10 - Rack and mounting bracket



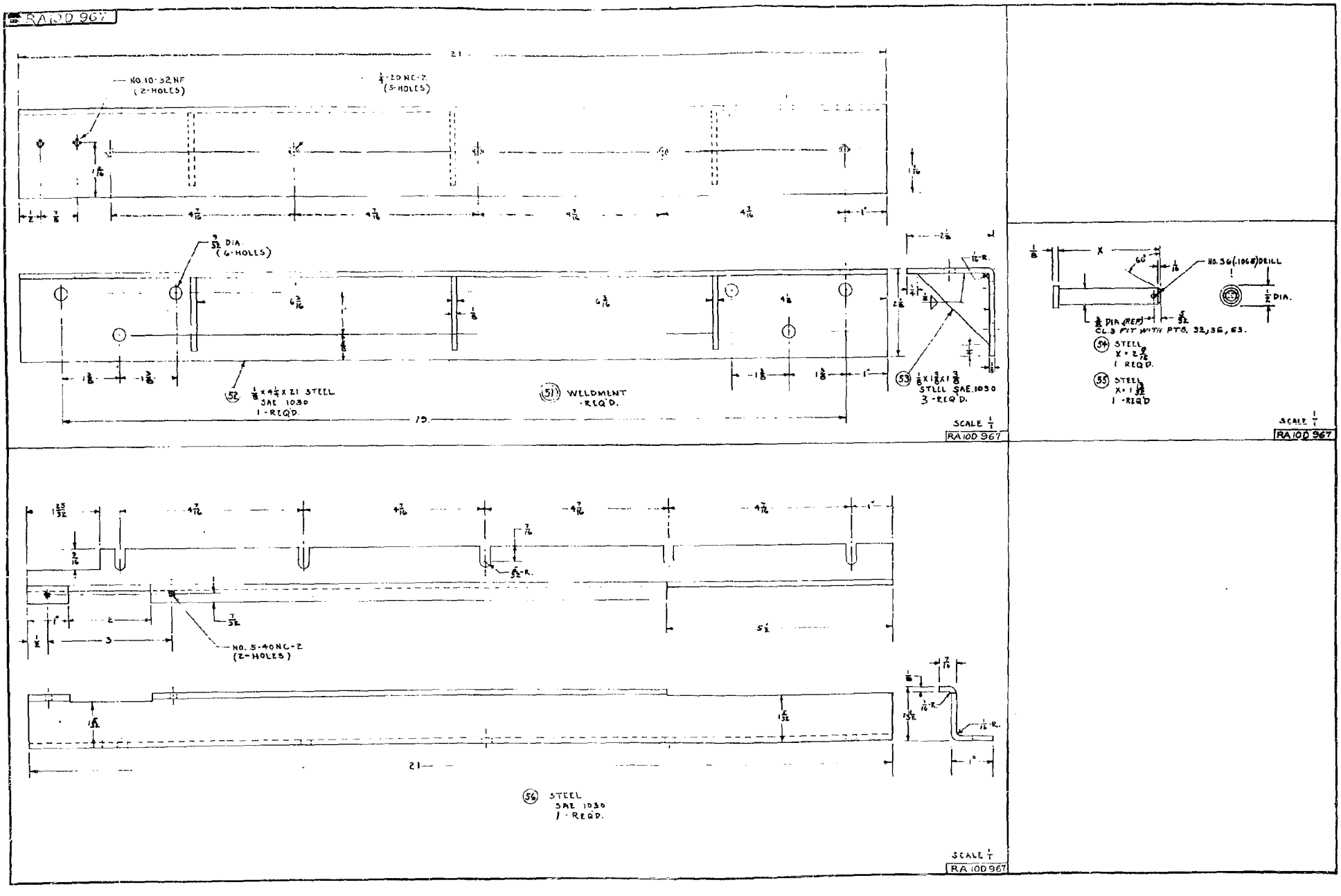
RA 10D 967 - Plate 11 - Assembly drawing of rack



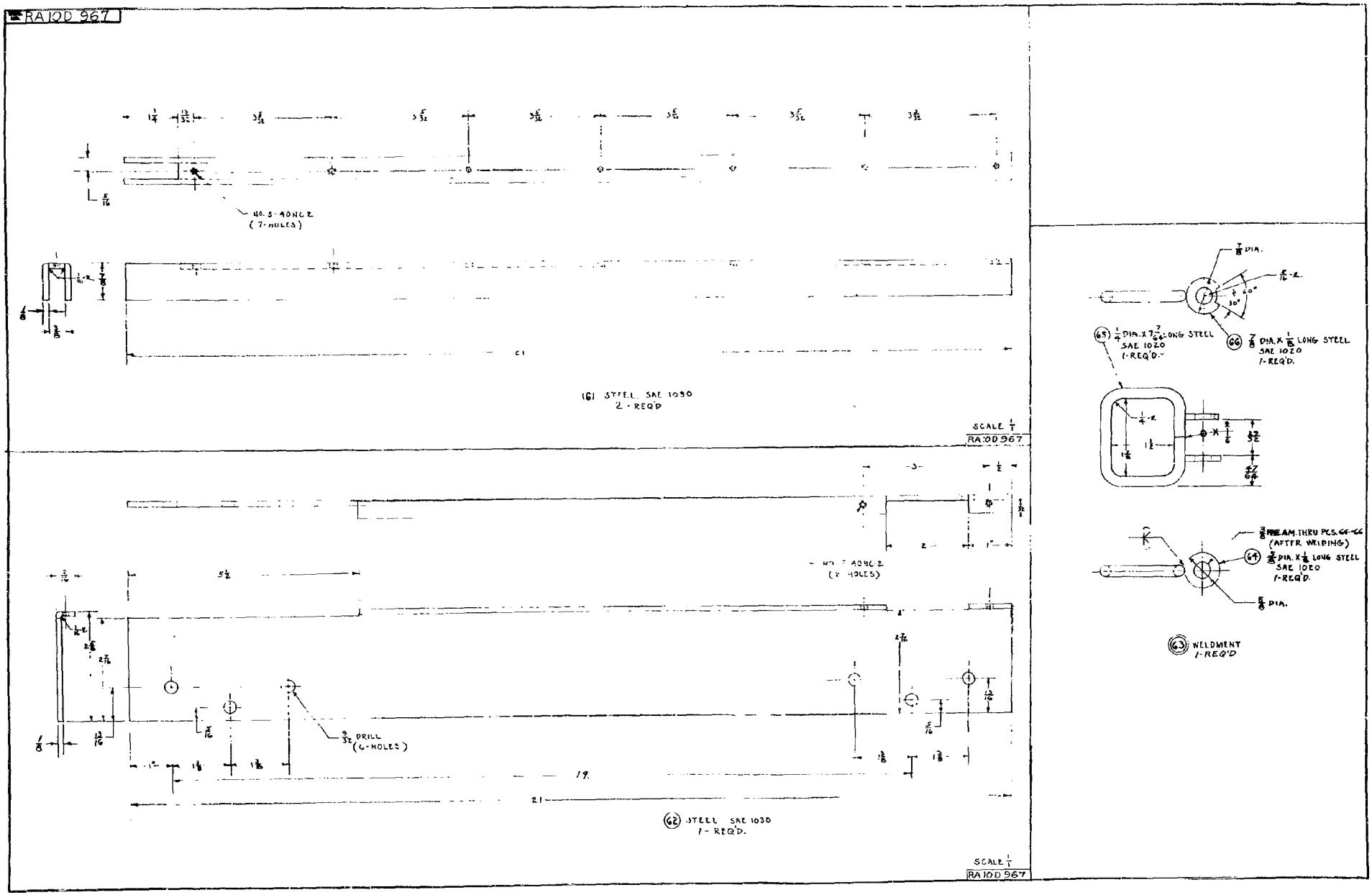
RA 10D 967 - Plate 12 - Details of rack



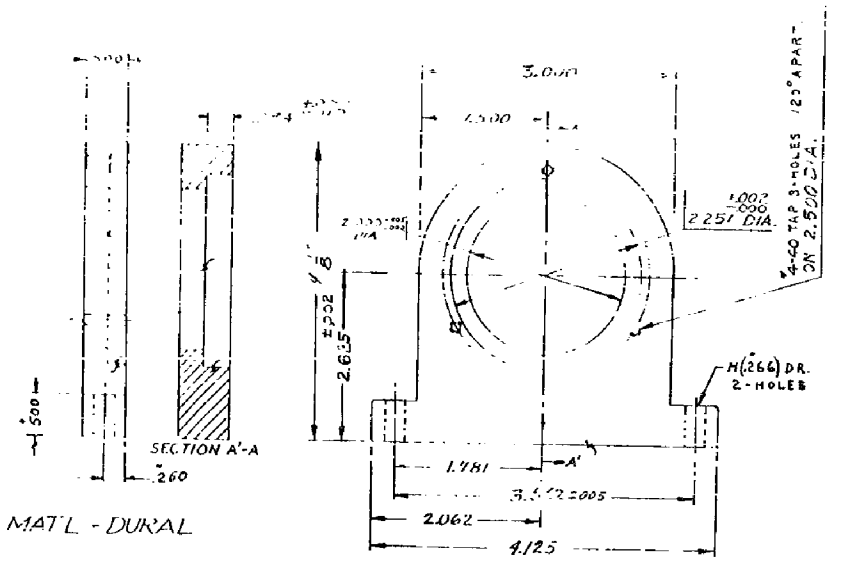
RA 10D 967 - Plate 13 - Details of rack



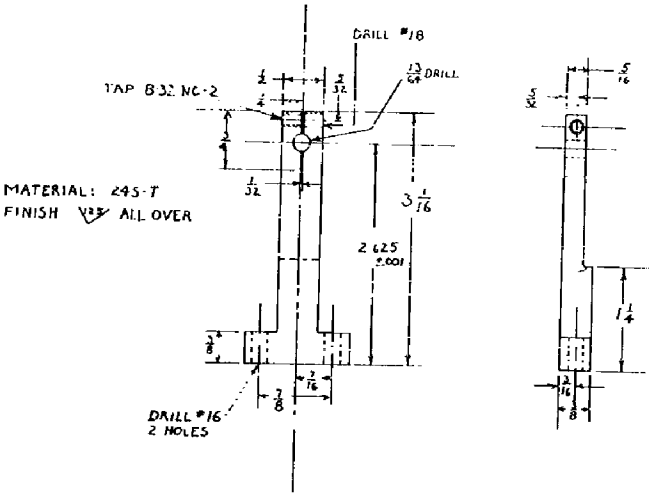
RA 10D 967 - Plate 14 - Details of rack



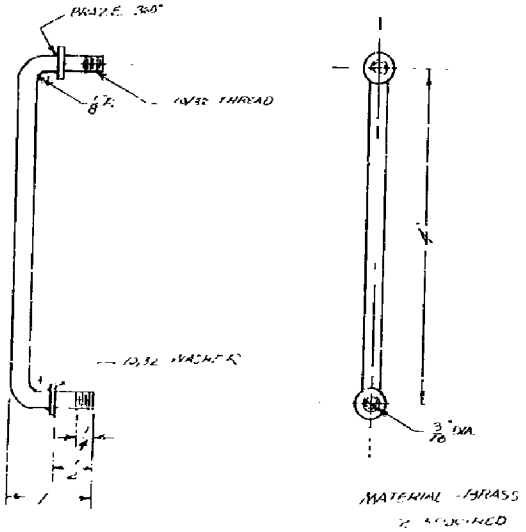
RA 10D 967 ~ Plate 15 - Details of rack



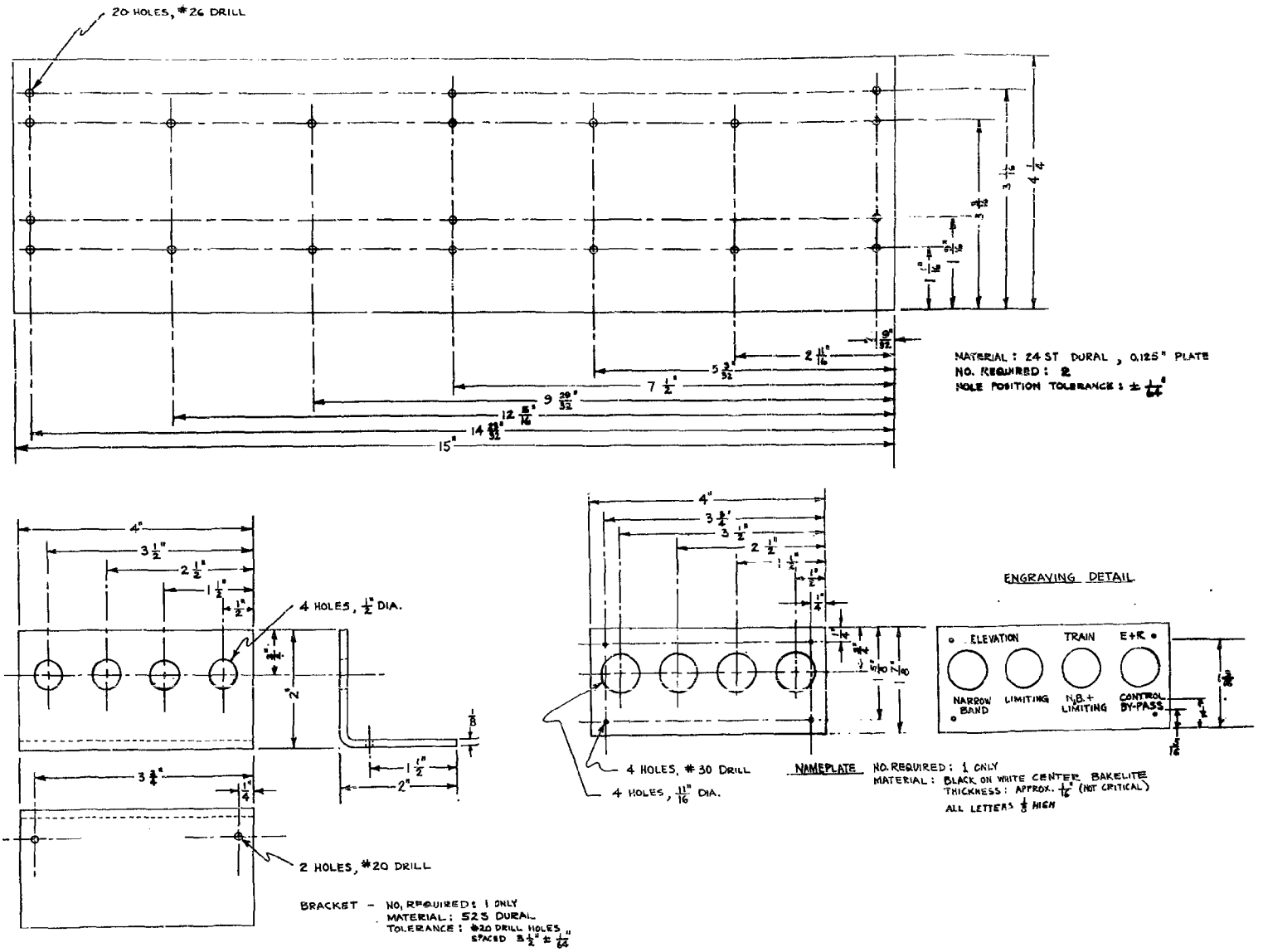
1100-SP-1821 - Plate 16 - Mount for size 1 synchro



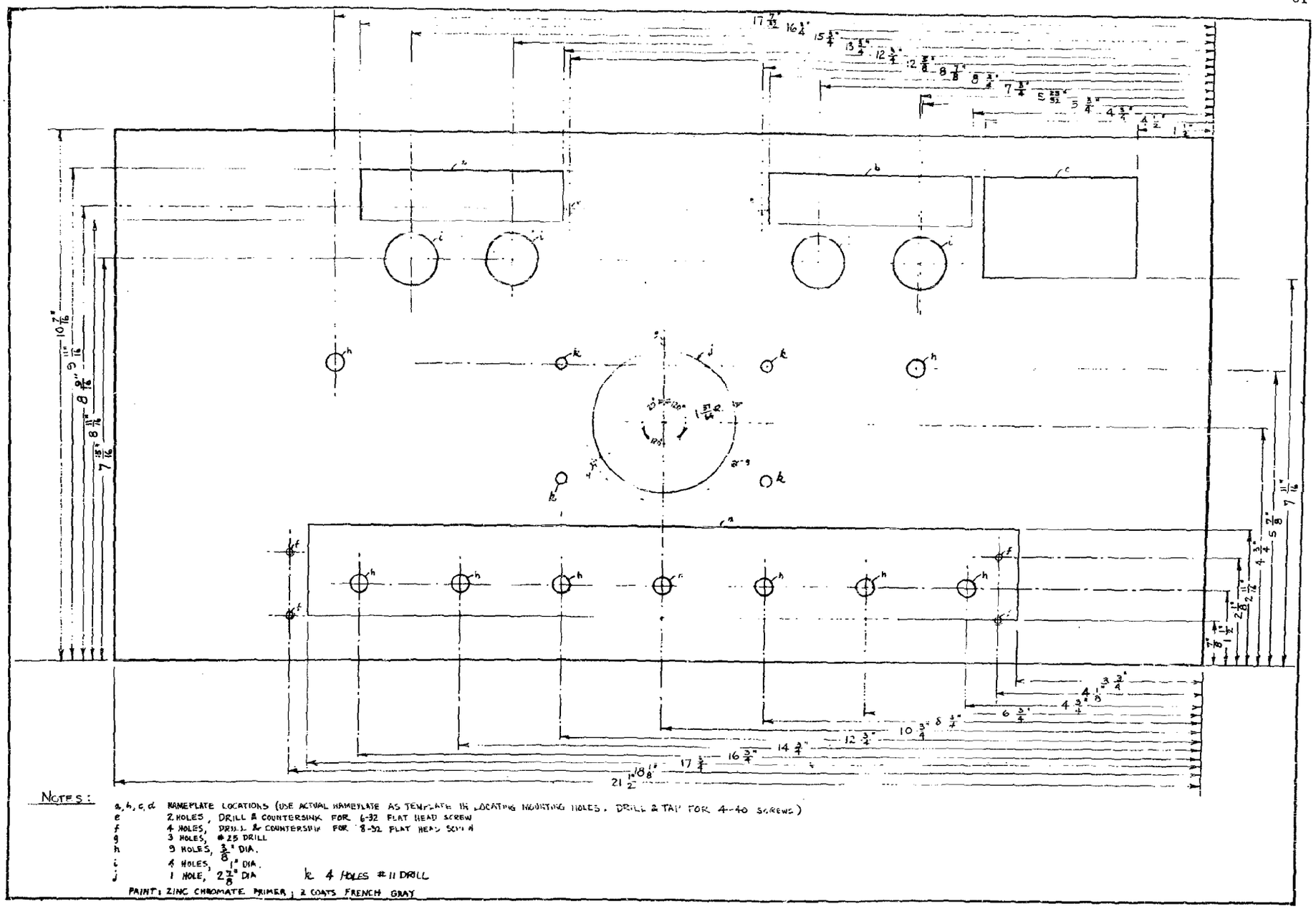
3600 A 2911 - Plate 17 - Clamp for 1-CT synchro



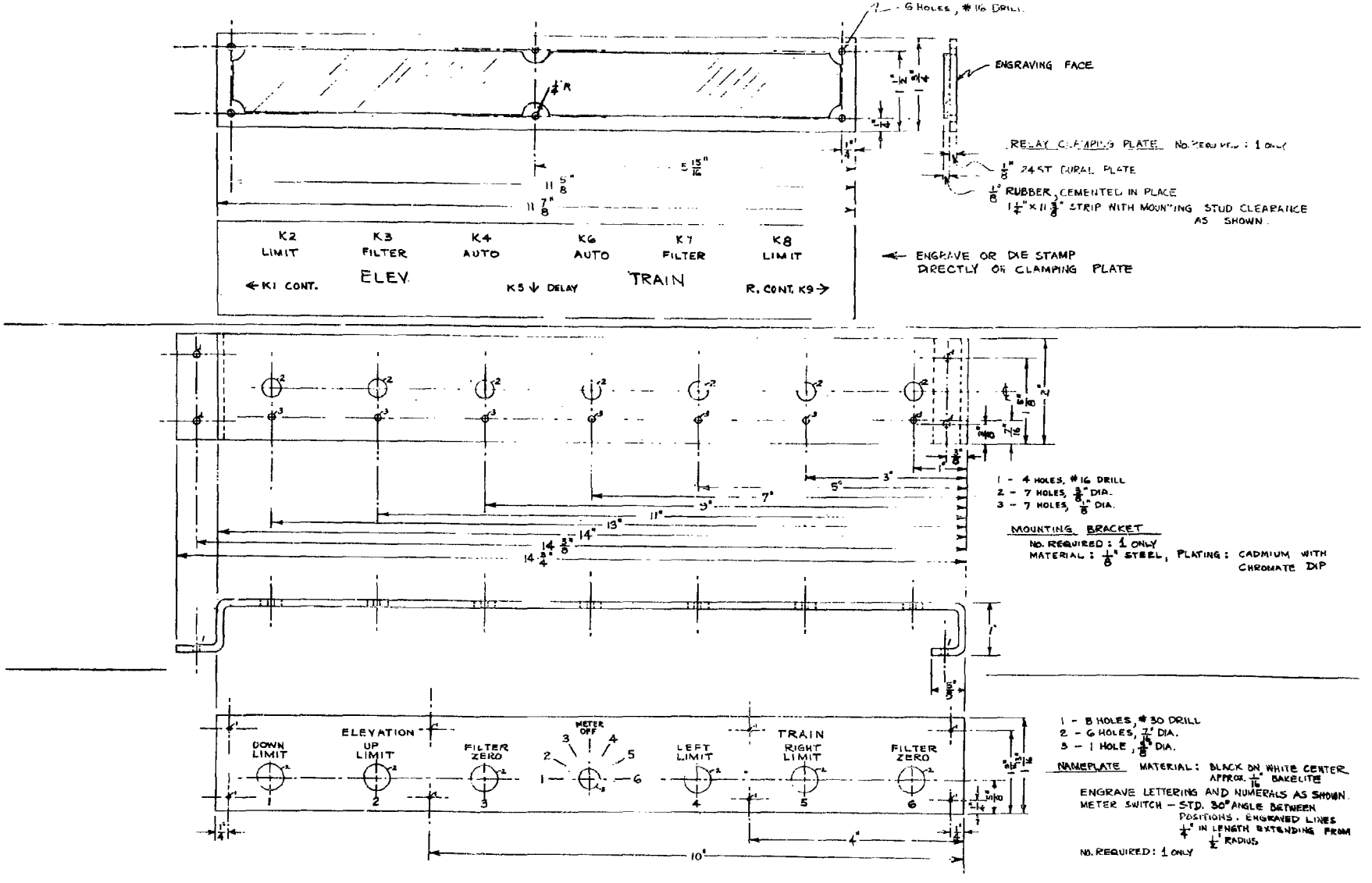
3600 A-6 - Plate 18 - Meter-face protector



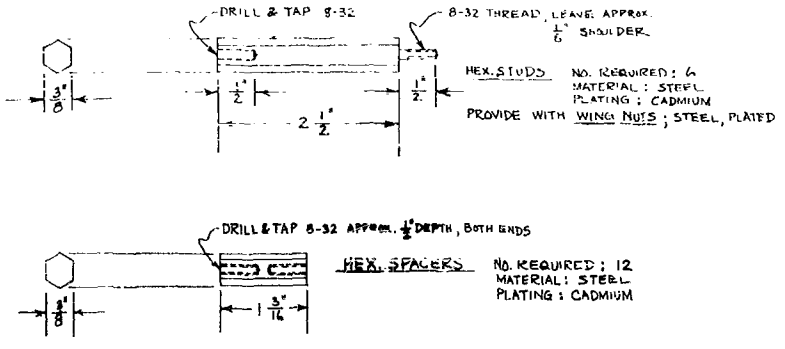
3600 C 2914 - Plate 21 - Components for AN/CP-191 (XB-1)/SPG

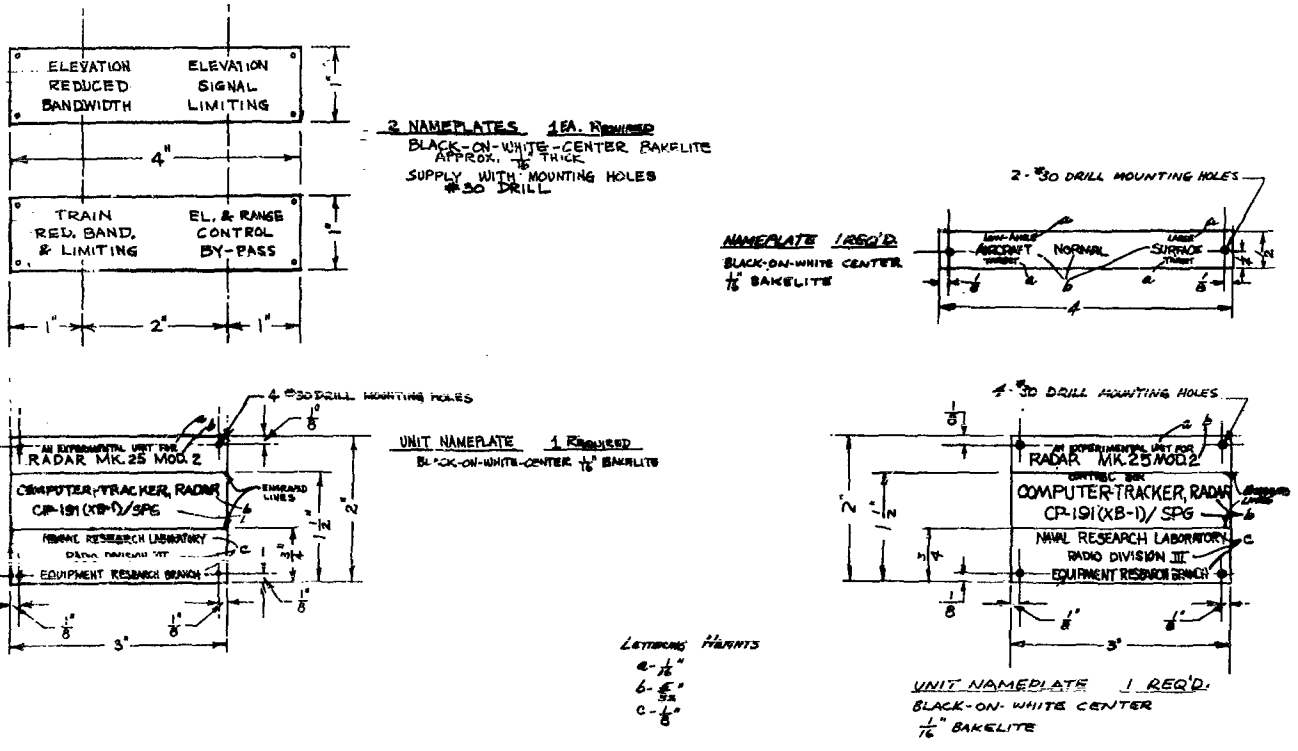


3600 C 2915 - Plate 22 - Panel detail



3600 C 2915 - Plate 23 - Components for AN/CP-191 (XB-1)/SPG





3600 C 2946 - Plate 24 - Components for AN/CP-191 (XB-1)/SPG

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Naval Research Laboratory. Report 4284.
PRELIMINARY INSTRUCTION MANUAL FOR AN/CP-191(XB-1)/SPG COMPUTER-TRACKER, RADAR UNIT FOR USE WITH GUN FIRE CONTROL SYSTEM MARK 37, by W. K. Whiting.
65 pp. & figs., February 17, 1954.

The AN/CP-191(XB-1)/SPG Computer-Tracker, Radar Unit is an experimental unit designed for fleet evaluation of the reduction in gun-order dispersion of the Gun Fire Control System Mark 37, under the adverse tracking conditions of low-evaluation-angle aircraft attack and of large surface ship attack. This reduced dispersion is due to improved operation of the Computer Mark 1A as provided by Ordnance Alterations 2626 and 3091, and to improved automatic tracking of

CONFIDENTIAL (Over)

1. Radar tracking systems – Instruction manuals
2. Computers – Instruction manuals

I. AN/CP-191(XB-1)/SPG

II. Whiting, W. K.

CONFIDENTIAL

Naval Research Laboratory. Report 4284.
PRELIMINARY INSTRUCTION MANUAL FOR AN/CP-191(XB-1)/SPG COMPUTER-TRACKER, RADAR UNIT FOR USE WITH GUN FIRE CONTROL SYSTEM MARK 37, by W. K. Whiting.
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CONFIDENTIAL (Over)

1. Radar tracking systems – Instruction manuals
2. Computers – Instruction manuals

I. AN/CP-191(XB-1)/SPG

II. Whiting, W. K.

the Radar Mark 25 Mod 2 as provided by this unit under these conditions. The improved tracking is the result of providing tracking performance commensurate with possible aggressive target maneuvers. This is achieved by reducing the bandwidths of the elevation and train automatic tracking servos and by the introduction of servo error signal limiting.

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the Radar Mark 25 Mod 2 as provided by this unit under these conditions. The improved tracking is the result of providing tracking performance commensurate with possible aggressive target maneuvers. This is achieved by reducing the bandwidths of the elevation and train automatic tracking servos and by the introduction of servo error signal limiting.

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UNITED STATES GOVERNMENT

memorandum

5300-31
DATE: 29 June 1998

REPLY TO ATTN OF: Code 5300

SUBJECT: REQUEST TO DECLASSIFY NRL REPORTS

TO: Code 1221.1 (C. Rogers)

1. It is requested that the NRL Reports listed below be declassified. The information contained in these reports has become public knowledge in the many years since first classified.

Declassified, public release.

3706 AD-C953460	4371 AD-038472	[redacted]	[redacted]	5338 AD-312117	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	5399 AD-314113	5540 AD-320263
[redacted]	[redacted]	5126 AD162728	5247 AD-304847	5403 AD-312699	5570 AD-320955
[redacted]	[redacted]	[redacted]	[redacted]	5441 AD-315354	
4284 AD031076	4878 AD-125352	5197 AD302457	[redacted]	5536 AD-343165	

Declassify, DoD and DoD contractors only.

4500	5511
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5508	

Will Send Later
TKS
Mary Templeman

G. V. Trunk

G.V. TRUNK
Superintendent
Radar Division